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Navy Obstetrics/Gynecology Physician Allocation Model

by

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Submitted in partial fulfillment
of the requirements for the degree of

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ABSTRACT

The availability of Obstetrics/Gynecology (OB/GYN) physicians is one of the most critical manpower issues facing Navy medicine. Insufficient recruitment efforts, coupled with poor retention rates have resulted in only 76.1% fulfillment of the authorized billets, which by FY-97, is projected to fall to 57.5% fulfillment. To meet the demand for OB/GYN services required by military beneficiaries, optimal allocation of existing assets as well as alternative means for delivering care must be fully examined. This thesis develops a mixed linear, integer program which optimizes the allocation of these scarce physician resources. Computational results are reported for realistic scenarios demonstrating the model's applicability. Model results consist of a recommended mix of OB/GYN provider assets that is different, in many instances, from the current staffing of Navy OB/GYN clinics. Additionally, reported results recommend closure of OB/GYN clinics where demand does not justify continued operations.

c.1

THESIS DISCLAIMER

The reader is cautioned that computer programs developed in this research may not have been exercised for all cases of interest. While every effort has been made, within the time available, to ensure that the programs are free of computational and logic errors, they cannot be considered validated. Any application of these programs without additional verification is at the risk of the user.

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I. INTRODUCTION

A. BACKGROUND

The availability of Obstetrics/Gynecology (OB/GYN) physicians is one of the most critical manpower issues facing Navy medicine. Current trends indicate that manning in FY-92 and the outyears will be less than 70% of what is required as illustrated in Figure 1 [Ref. 1].

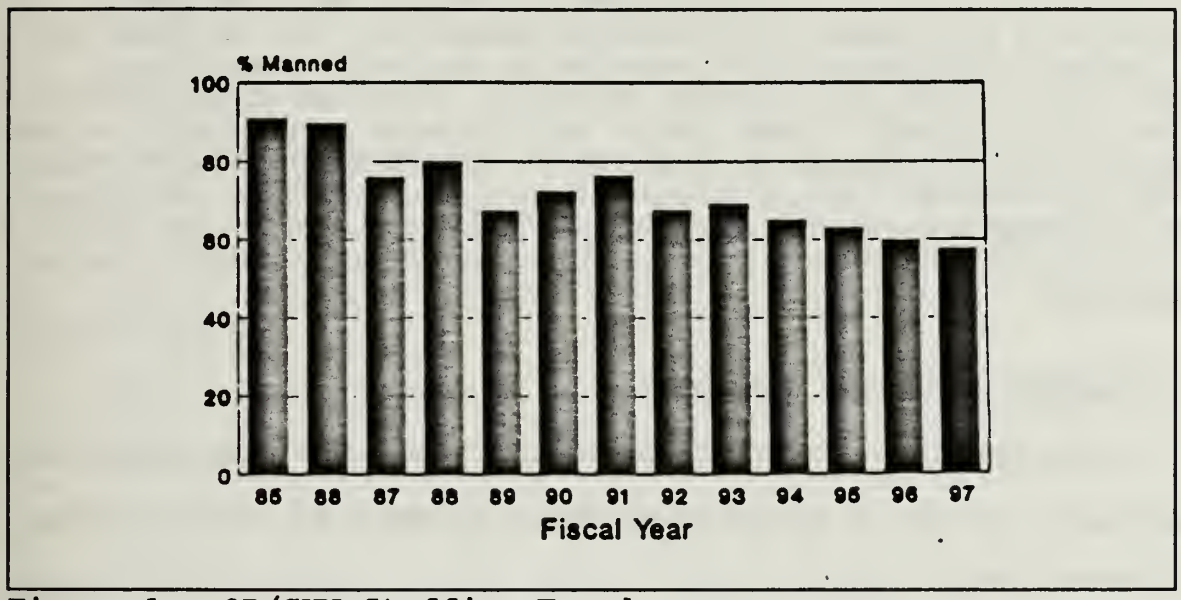

Figure 1. OB/GYN Staffing Trend

Insufficient recruitment efforts, coupled with poor retention rates have resulted in only 76.1% fulfillment of the authorized billets, which by FY-97, is projected to fall to 57.5% fulfillment [Ref. 1]. Numerous factors have been cited for the discontent and associated poor retention rates in the OB/GYN specialty. Among them are long hours, heavy workload,

a large compensation differential between military and civilian practice, and lack of adequate ancillary support and modern, state-of-the-art medical equipment [Ref. 2].

A number of initiatives [Ref. 2] aimed at improving the quality of professional life and retention among Navy OB/GYN physicians have begun. Although these measures may eventually be implemented, a serious manpower shortage is inevitable for the next several years.

Innovative means of delivering OB/GYN services must be introduced to combat the manpower shortage. To continue to meet the demand for OB/GYN services required by military beneficiaries, optimal allocation of existing assets, as well as alternative means for delivering care must be fully examined.

B. OBJECTIVE OF THE RESEARCH

The objective of this thesis is to develop a tool which can assist Navy medical manpower planners in devising an OB/GYN staffing plan.

A mixed linear, integer program is developed to accomplish this objective. The model optimally allocates the existing inventory of Navy OB/GYN physicians and alternative provider types to the 35 Military Treatment Facilities (MTFs) operated by the Navy in the United States (CONUS) and overseas (OCONUS). This provider allocation, whenever possible, satisfies estimated minimum levels of clinical and teaching

demand at each facility without violating the supply of each provider type available. Closure of a facility's OB/GYN service is also considered by the model. The 35 MTFs and their associated FY-90 key operating statistics are shown in Appendices A and B [Ref. 3].

The methodology used to define demand is discussed in Chapter II, and the mixed linear, integer program is presented in Chapter III.

C. SCOPE AND LIMITATIONS OF THIS STUDY

This thesis develops a mathematical formulation using a set of simplifying assumptions (discussed in Chapter II), and constraint sets derived from numerous *Bureau of Medicine and Surgery (BUMED), Washington, D.C.* correspondence relevant to OB/GYN issues.

Not all data inputs to the model are readily available, and portions of the available data are incomplete or inaccurate. Assumptions are made and noted throughout this thesis to overcome these data difficulties. The results obtained from this model should be viewed as preliminary and interpreted with caution and judgement. As future systems are developed to capture Navy medical data more completely and accurately, this model can be used more extensively as a decision-making tool.

D. ORGANIZATION OF THE THESIS

Chapter II describes the methodology employed in this study. Basic definitions relevant to the *Military Health Services System (MHSS)* and an overview of *BUMED* are presented. Assumptions are discussed, the definition of OB/GYN demand explained, the data used in the model is discussed, and the alternative means for delivering OB/GYN services are presented and defined. Chapter III develops the mathematical model. The objective function and associated constraint sets are presented and fully explained. Chapter IV provides an analysis of the model results and also conducts an extensive sensitivity analysis. Finally, Chapter V presents conclusions, recommendations, and areas for future expansion.

II. METHODOLOGY, DEFINITIONS, DATA, AND ASSUMPTIONS

A. PROBLEM STATEMENT

As previously mentioned, a severe shortage of Navy OB/GYN physicians exists, and the situation is not expected to improve in the near future. To assist in dealing with this problem, this study examines the most cost-effective way to deliver Navy OB/GYN services by recommending the optimal mix of OB/GYN healthcare providers. A mathematical model is developed to accomplish this objective. This model is fully presented in Chapter III.

The model minimizes the annual costs of delivering OB/GYN services plus penalties for not meeting demand for services. Penalties are incurred only when no other option exists to deliver the required level of service. The optimal mix of Navy OB/GYN physicians, Navy Certified Nurse Midwives (CNMs), Navy Family Practice (FP) physicians, civilian partnership OB/GYN physicians, civilian contract physicians, and CHAMPUS OB/GYN physicians is provided by the model while, ideally, ensuring the following:

- Demand for OB/GYN providers is met at each hospital,
- Additional demand is met at teaching hospitals,
- Demand in excess of a facility's physical capacity is absorbed by the CHAMPUS program,

- Fixed supplies of the various provider types are not exceeded,
- OB/GYN clinics are closed at facilities where demand does not justify continued operations.

Elastic variables with penalties are employed by the model in the first three constraints since it may be impossible to satisfy the constraints.

The four alternatives to Navy OB/GYN physicians and CHAMPUS OB/GYN physicians mentioned above are fully described in Section F of this chapter.

The next two sections provide information on how the headquarters for Navy medicine is organized, and how the *Military Health Services System (MHSS)* functions. These sections provide background material for the interested reader, but they can be skipped without any loss of understanding.

B. THE BUREAU OF MEDICINE AND SURGERY

The stated mission of the Navy Medical Department is two-fold: (1) to support the operating forces of the Navy and Marine Corps, and (2) to provide quality healthcare services to active and retired Navy and Marine Corps families. Coordinating the efforts to carry out this mission is the *Bureau of Medicine and Surgery (BUMED)*, the headquarters for Navy medicine, located in Washington, D.C.

There are approximately 390 personnel assigned to *BUMED* consisting of 150 officers, 40 enlisted, and 200 civilians. Medical personnel resources Navy-wide (as of 30 September 1991) consist of the numbers and types indicated in Tables I, II, and III. The officer total in Table I represents 13% of the Navy/Marine Corps officer population and the enlisted total in Table II corresponds to 4.6% of the Navy/Marine Corps enlisted population. [Ref. 4]

BUMED manages the following activities [Ref. 4]:

- Five Healthcare Support Offices (HSOs) located at San Diego, Pearl Harbor, Jacksonville, Norfolk, and London,
- One Office of Medical/Dental Affairs (OMDA) located at Great Lakes,
- 33 Hospitals and two Branch Hospitals located CONUS and OCONUS, including nine Graduate Teaching Hospitals,
- 211 Medical Clinics,
- 141 Dental Clinics (DTFs),
- Ten NAVCARE Clinics,
- 11 Research and Development Activities,
- 15 Fleet Hospitals (equipped and ready),
- Two Fleet Hospitals (held in bulk storage),
- Two Hospital Ships (USNS Mercy and USNS Comfort),
- One Rapidly Deployable Medical Facility (RDMF).

TABLE I. NAVY MEDICINE'S OFFICER POOL

TYPE	NUMBER
Physicians	4,361
Dentists	1,665
Nurses	3,200
Physician Assistants	146
Allied Health	1,323
Administrators	1,400
TOTAL	12,095

TABLE II. NAVY MEDICINE'S ENLISTED POOL

TYPE	NUMBER
Hospital Corpsmen	27,983
Dental Technicians	3,554
TOTAL	31,537

TABLE III. OTHER MEDICAL PERSONNEL

TYPE	NUMBER
Civilians	13,013
Select Reserves	19,173
TOTAL	32,186

C. MILITARY HEALTH SERVICES SYSTEM PATIENT CARE

Care delivered under the *MHSS*, of which Navy medicine is a part, is categorized by the following groups:

- Direct care,
- CHAMPUS (Civilian Health and Medical Program of the Uniformed Services) care,
- Supplementally funded care.

Direct care consists of all services provided inside the MTF to active duty personnel, dependents of active duty personnel, retirees, and dependents of retirees. All attempts are made by the *MHSS* to maximize the use of direct care by expanding the medical specialty services provided and by improving patient accessibility. When the MTF does not have the capability to provide a service either due to nonexistence of the medical specialty or due to excessive demand, the patient(s) must be referred outside the MTF for the required

services. If it is cost-effective, and feasible, all attempts are made to direct the referral to another MTF within the *MHSS*. More often than not, however, the referral must be made to a civilian source of care within the locality of the referring MTF. A referral to a civilian source, is financed through either the CHAMPUS program or through supplemental funds depending on the status of the patient.

CHAMPUS is a federally funded program designed to assist military beneficiaries with medical costs incurred when treatment is unavailable through the *MHSS* direct care system. Dependents of active duty personnel, retirees under age 65 (retirees over 65 lose their CHAMPUS benefits once they become eligible for MEDICARE), or dependents of retirees are covered under CHAMPUS.

Active duty patients are not covered by the CHAMPUS program and any civilian medical care must be paid through supplemental funds. These medical bills are financed through the *Operations & Maintenance (O&M)* budget of the referring MTF.

More detail on the topics discussed above can be found in the following Navy medicine instructions:

- NAVMEDCOMINST 6320.3B (Medical and Dental Care for Eligible Persons at Navy Medical Department Facilities),
- NAVMEDCOMINST 6320.1A (Nonnaval Medical and Dental Care),
- NAVMEDCOMINST 6320.18 (Civilian Health and Medical Program of the Uniformed Services [CHAMPUS] Regulations).

D. DEFINING OBSTETRICS/GYNECOLOGY (OB/GYN) DEMAND

In optimally allocating OB/GYN healthcare providers, demand for services must be satisfied in the best possible way. Clinical demand for OB/GYN services at each facility consists of the workload generated by the three areas of care -- direct care, CHAMPUS care, and supplementally funded care. At hospitals operating residency programs, there is additional demand for OB/GYN providers serving as teachers.

The data on supplementally funded referrals is not readily available by medical specialty or disaggregated to the MTF level. Furthermore, a relatively small portion of the total OB/GYN workload is generated by this piece of demand [Ref. 5]. Therefore, an assumption is made that demand at each MTF will be due only to the MTF's direct care and CHAMPUS workload.

Another assumption is made regarding the unit of workload to quantify demand. Due to the multitude of different OB/GYN procedures that exist and due to the comparability problem that exists between the way CHAMPUS data is collected versus the way direct care data is collected, a simplifying measure of demand is needed. To further explain the problem in matching up CHAMPUS data and direct care data, a brief explanation of the collected data follows.

The CHAMPUS workload and the direct care workload for inpatient care is summarized using *Diagnosis Related Groups (DRGs)*. *DRGs* classify patients by demographic and diagnostic

variables into clinically comparable groups with similar lengths-of-stay and intensities of resource consumption. Originally developed for medical utilization review in the civilian sector, the *DRG* classification scheme has been adopted as the basis to credit workload and allocate resources within the Department of Defense (DoD) *MHSS*. Under this system, relative workload credit is based on average resource use within each *DRG* category. A fixed credit is given for the entire episode rather than crediting separately each input (occupied bed days, ancillary tests, pharmaceuticals, etc.) consumed during the episode. This methodology provides incentives for efficiency and effectiveness in managing the inpatient case and enhances comparisons with patient care in the civilian sector. There are 473 different *DRGs*. *DRGs* relevant to OB/GYN cases consist of *DRGs* 353-384. [Ref. 6]

For outpatient workload, the CHAMPUS data is summarized by medical procedure using *Physicians' Current Procedural Terminology (CPT)* coding. *CPT* coding provides descriptive terms and identifying codes for reporting medical services and procedures performed by physicians. The purpose of the terminology is to provide a uniform language that accurately describes medical, surgical, and diagnostic services, and thereby provides an effective means for reliable nationwide communication among physicians, patients, and third parties. [Ref. 7]

In the MTFs, however, the outpatient workload data generated under the direct care system is not collected at any level of detail. MTFs do not currently use *CPT* coding, and the level of disaggregation available is simply the total expense and number of obstetrics outpatient visits, and the total expense and number of gynecology outpatient visits occurring at each MTF.

So, although the inpatient workload under CHAMPUS and direct care could be compared since both are collected using *DRGs*, the outpatient workload under the two types of care is not comparable since the direct care system does not employ *CPT* coding. Because of this complication, the OB/GYN demand for an MTF is defined as the total number of deliveries (births) recorded by the MTF in a selected fiscal year:

$$DEMAND = CHAMPUS_{DELIVERIES} + DIRECT\ CARE_{DELIVERIES} \qquad (2.1)$$

Using annual deliveries as a measure of OB/GYN demand is reasonable if the number of providers required for other OB/GYN services is well approximated by the number required to handle annual deliveries. This study assumes that this relationship between deliveries and the other OB/GYN procedures holds. A more detailed and accurate measure of OB/GYN demand could be developed by incorporating all the medical procedures that fall under obstetrics and gynecology.

However, the benefits realized by doing this would probably not justify the derivation of such a complex demand function.

Using the definition developed in this section, the FY-90 demand levels used in the computational work of this thesis appear in Appendices C and D [Ref. 3]. FY-91 data does not represent a typical year of operations due to Desert Shield/Desert Storm.

E. DISCUSSION OF DATA

1. Sources of Data

Data used by the model includes the demand at each facility, the additional demand that must be satisfied at teaching hospitals, the available supplies of the healthcare provider types, and the physical capacity at each MTF. The various sources of these data elements are discussed in this section.

The three main data sources used for this study are the FY-90 Health Care Planning Matrix (HCPM) [Ref. 3], distributed by the Naval Medical Data Services Center (NMDSC) in Bethesda, MD; the FY-90 Medical Expense and Performance Reporting System (MEPRS) report [Ref. 8], distributed by NMDSC and BUMED; and the CHAMPUS Health Care Summary Report (HCSR) for the period April 1990 - March 1991 [Ref. 9], distributed by the Office of CHAMPUS (OCHAMPUS) in Aurora, CO.

From the HCPM, the following data elements are extracted:

- Demand at each MTF (listed as the number of births under both CHAMPUS and direct care),
- Supply of CHAMPUS, partnership, and contract OB/GYN physicians available at each MTF (listed as the estimated number of civilian OB/GYN physicians in the area),
- Supply of military Family Practice (FP) physicians available at each MTF (listed as the number of FP physicians onboard),
- Delivery rooms at each MTF (listed as the number of delivery rooms in use).

Additional data inputs to the model are obtained from a *BUMED* correspondence regarding an "OB/GYN Specialty Distribution Plan" [Ref. 10]. This memorandum provides information on the number of OB/GYN physicians required at MTFs that are teaching hospitals. These facilities require additional OB/GYN assets to support their Graduate Medical Education (GME) programs.

A *BUMED* memorandum on "Navy Certified Nurse Midwives: Proposal for Phased Community Growth" [Ref. 11] provides the number of midwives currently available for allocation. Another *BUMED* memorandum [Ref. 1] indicates the number of military OB/GYN physicians currently available to Navy medicine.

From the MEPRS and HCSR, a total OB/GYN expense for each MTF generated by direct care and CHAMPUS respectively is extracted. Dividing this by the number of deliveries yields a total cost per delivery. These equations are as follows:

$$\frac{MEPRS\ EXPENSE}{DIRECT\ CARE\ DELIVERIES} = TOTAL\ COST/DELIVERY_{DIRECT} \qquad (2.2)$$

$$\frac{HCSR\ EXPENSE}{CHAMPUS\ DELIVERIES} = TOTAL\ COST/DELIVERY_{CHAMPUS} \qquad (2.3)$$

Equation (2.2) is used to compute the total direct care cost per delivery for each MTF, and equation (2.3) is used for calculating the total CHAMPUS cost per delivery.

2. Assumptions Concerning the Data

In computing the total direct care and total CHAMPUS cost per deliveries as previously mentioned, certain MTFs did not have FY-90 workload in *DRGs* 372 and 373 (i.e., the *DRGs* corresponding to deliveries), or for OB/GYN, in general. Therefore, equations (2.2) and (2.3) could not be used. For these MTFs, a total cost per delivery is assigned by using the average of the other MTFs' total costs per delivery. For total CHAMPUS cost per delivery, an average is assigned for Corpus Christi, Great Lakes, Groton, Long Beach, Newport, Orlando, and Philadelphia. For total direct care cost per delivery, an average is assigned for Corpus Christi, Great Lakes, Groton, Long Beach, Newport, Philadelphia, 29 Palms, Keflavik, and Sigonella.

Total costs per delivery using alternative provider types are currently not available. As previously mentioned,

alternatives to CHAMPUS and military OB/GYN physicians considered in this study are military FP physicians, military CNMs, civilian partnership OB/GYN physicians, and civilian contract OB/GYN physicians.

Although actual total costs per delivery using these other provider types are not known, the following relative ordering of costs is assumed:

$$CNM < FP < partnership < contract \qquad (2.4)$$

Costs for these provider types at each MTF are assumed to be a certain percentage of the total direct care cost per delivery computed for that MTF. These assumed percentages are indicated in Table IV.

TABLE IV. PERCENTAGES FOR TOTAL COST/DELIVERY

CNM	65% of Total Cost/Delivery$_{DIRECT}$
FP Physician	80% of Total Cost/Delivery$_{DIRECT}$
Partnership Physician	105% of Total Cost/Delivery$_{DIRECT}$
Contract Physician	110% of Total Cost/Delivery$_{DIRECT}$

The reasoning behind the inequalities expressed in (2.4) is as follows:

- A CNM is assumed to cost less than a FP physician because the main expense allocated per delivery by these provider types is the labor dollars. A CNM is a nurse, whereas a FP physician is a doctor. The total cost per delivery by the FP physician is greater than that of the CNM due to the higher salary.
- The partnership physician is assumed to cost less than the contract physician because past experience has indicated that partnership arrangements can usually be negotiated at lower rates than contracts (partnerships and contracts are discussed in more detail in Section F of this chapter).
- Regarding the middle inequality, there is more uncertainty as to whether or not the CNM and the FP cost less than the partnership and the contract. It is assumed that they do cost less because the former two are in-house military personnel, whereas the latter are civilian sources of healthcare. Chapter IV examines the implications of this inequality being reversed.

F. ALTERNATIVES IN THE DELIVERY OF OB/GYN CARE

This section provides detailed descriptions of the alternative healthcare options considered by the model.

Options not considered in this study due to inadequate data are the use of Physician Assistants (PAs), OB/GYN Nurse Practitioners, FP Nurse Practitioners, reservists, and civil service OB/GYN physicians. Collection of the data required to model these other options could be a beneficial expansion to the model.

1. Certified Nurse Midwives

A nurse-midwife is defined as a registered professional nurse who has successfully completed an educational program recognized by the *American College of Nurse-Midwives* and approved by the *Chief, BUMED*. A nurse-midwife functions in an expanded and specialized area of nursing. This practitioner possesses the knowledge and clinical skills required to accept and provide for the interdependent management of women with essentially normal pregnancies and management of essentially normal newborns. [Ref. 12]

As stated previously [Ref. 11], there are currently 11 CNMs in the Navy. Plans are to increase this number to 20 by FY-94 [Ref. 11].

2. Military Family Practice Physicians

For those MTFs that have FP physicians assigned to them, these provider types can serve as an excellent mechanism for augmenting the OB/GYN capabilities of the facility. These physicians are trained in delivering routine OB/GYN care, and they can also treat complicated cases by having direct access to consultation from an OB/GYN physician [Ref. 10].

3. Civilian Partnership OB/GYN Physicians

The *Partnership Program* allows CHAMPUS-eligible beneficiaries to receive inpatient and outpatient medical care from private CHAMPUS-authorized health care providers

practicing full or part-time within an MTF [Ref. 13]. MTFs can enter into partnership agreements by issuing a *Memorandum of Understanding (MOU)* between the MTF and the provider. The partnership provider agrees to charge a mutually acceptable percentage of the CHAMPUS prevailing rates for all services performed under the partnership agreement.

MTFs can expand their capability to deliver medical services by incorporating partnership providers into their facilities. Additionally, the government usually benefits from these agreements because partnership providers are reimbursed through the CHAMPUS budget and usually their charges are at a discounted level compared to the prevailing CHAMPUS rates.

4. Civilian Contract OB/GYN Physicians

In January 1987, at the request of the Chief of Naval Operations, *BUMED* was directed to develop a plan with the primary objective of reducing overall Navy CHAMPUS costs. This plan includes optimizing the use of Navy MTFs and DTFs, while maintaining the existing high quality of health care. [Ref. 14]

Several methods were identified to accomplish this objective including the reprogramming of active duty military and civilian personnel, partnership agreements, use of DoD and Department of Veterans Affairs resource sharing, interservice or intraservice resource sharing, and health care contracting.

With the majority of these methods already in place, health care contracting was selected as another alternative for optimally delivering quality health care. It would bring needed physicians to the treatment facility so that outpatients and inpatients could be treated using available internal support services that would otherwise be inefficiently used. [Ref. 14]

G. LEVELS OF CARE & FACILITY CAPACITY

Appropriate levels of care for various provider types are set as policy by organizations such as the *American College of Obstetrics and Gynecology (ACOG)*. This thesis uses 180 deliveries per year as the level of productivity for OB/GYN physicians assigned primarily for clinical duties, 60 deliveries per year for FP physicians, and 120 deliveries per year for CNMs [Ref. 10]. OB/GYN physicians assigned solely for teaching duties would logically be able to perform less than 180 annual deliveries due to their teaching responsibilities. Therefore, 50 deliveries per year is assumed to be the productivity level for an OB/GYN physician assigned solely as a teacher. As an example, an MTF with a demand of 1800 annual deliveries requires ten clinical OB/GYN physicians, or five clinical OB/GYN physicians and 15 FP physicians. This methodology assumes that the assigned providers meet the total demand for OB/GYN services at a fixed

ratio which is not dependent on the provider type or assigned mission.

For quantifying the physical capacity of an MTF, it is assumed that 600 deliveries can be performed annually for each delivery room in use at the MTF [Ref. 10]. As an example, an MTF with two delivery rooms in use has an annual physical capacity of 1200 deliveries.

H. OTHER ASSUMPTIONS

There is a strong desire by *BUMED* and the OB/GYN Specialty Advisor to staff all OB/GYN clinics with at least three OB/GYN physicians. The reason for this requirement is that the life-style of an OB/GYN physician makes *port and starboard* or *port and report* watches unacceptable (i.e., in a one-man shop, the same physician must be on-call every night, or in a two-man shop, every other night). These watches have a severe negative impact on retention rates in the OB/GYN community. [Ref. 15]

Regarding this desire to avoid one or two-man shops, it is assumed that the requirement to have at least three OB/GYN physicians must be met for OCONUS, isolated, or medically underserved MTFs. These MTFs have no access to medical care outside their facilities (CHAMPUS, partnerships, and contracts are not available), so all demand must be met in-house using military OB/GYN provider assets (i.e., military OB/GYN physicians, FP physicians, and CNMs).

For those MTFs that are not OCONUS, isolated, or medically underserved, the staffing requirement of at least three OB/GYN physicians is necessary if the decision is made to operate an OB/GYN service at the MTF. If a service is to be provided, the staffing requirement of at least three physicians can be met by any combination of military, partnership, or contract OB/GYN physicians. This is assumed because the main reason for having at least three physicians is to make the on-call schedule a little more reasonable than it would be with a one or two-man shop, and it is assumed that any of the physicians can be used to cover the on-call schedule (regarding partnership and contract physicians, this on-call requirement would have to be written into the *MOU* or contract agreement).

III. MODEL DEVELOPMENT

The model's objective is to minimize the annual operating costs of delivering OB/GYN services plus penalties, subject to the following constraints:

- Meet demand for OB/GYN providers at each hospital, or incur a penalty,
- Meet additional demand at teaching hospitals, or incur a penalty,
- Ensure that demand in excess of physical capacity is absorbed by the CHAMPUS program, or incur a penalty,
- Ensure that provider supplies are not exceeded,
- Staff CONUS hospitals with at least three OB/GYN physicians, or close the facility's OB/GYN service (in instances where a facility's service is closed, the avoided fixed costs are not considered in this study),
- Staff OCONUS/isolated hospitals with at least three military OB/GYN physicians (closure of the service is not permitted, and civilian providers are not available).

Elastic variables are employed in the first three constraints since it may be impossible to satisfy the constraints. Whenever the model uses an elastic variable, the objective function value is penalized for its use. These penalty costs are set high enough so that the model only uses elastic variables when there is no other way to achieve a feasible solution.

The model optimally allocates the following provider types to each facility:

- Navy OB/GYN physicians,
- Navy CNMs,
- Navy FP physicians,
- Civilian partnership OB/GYN physicians,
- Civilian contract OB/GYN physicians,
- CHAMPUS OB/GYN physicians.

The Navy OB/GYN physicians, CNMs, and FP physicians are *full-time* military personnel which the model assigns in integer quantities. The partnership, contract, and CHAMPUS OB/GYN physicians are civilian personnel. Their services can be provided on a *part-time* basis, so the model assigns these assets in continuous quantities.

The following sections list the components of the model (refer to Appendix E for an implementation of the model).

A. INDICES

- H - Navy hospitals (refer to Appendices A and B for listings of these facilities),
- CH - Subset of Navy hospitals consisting of the CONUS facilities,
- M - Primary mission of the assigned provider (clinical, teaching),

- P - Healthcare provider types (Navy OB/GYN physician [OBGYN], Navy CNM [MIDWIFE], Navy FP physician [FAMPRAC], partnership OB/GYN physician [PARTNER], contract OB/GYN physician [CONTRACT], CHAMPUS OB/GYN physician [CHAMPUS]),

- N - Subset of the healthcare provider types containing the Navy OB/GYN physicians [OBGYN] and the Navy CNMs [MIDWIFE].

B. GIVEN DATA

- $SUPP_N$ - Supplies of provider types in subset N,

- $CAPAC_H$ - Physical capacity at H,

- $COST_{P,H}$ - Cost/delivery by provider P at H (in the implementation of the model (Appendix E), these costs are scaled by a linear constant),

- $CLINCOST_H$ - Penalty cost for using elastic variable $DEVC_H$ (given a value of 50 in this study),

- $TEACHCOST_H$ - Penalty cost for using elastic variable $DEVT_H$ (given a value of 1000 in this study),

- $CHAMPCOST_H$ - Penalty cost for using elastic variable $ELASTCHAMP_H$ (given a value of 1.5 * $COST_{CHAMPUS,H}$),

- $CLINDMD_H$ - Clinical demand at H (expressed as a number of deliveries),

- $TEACHDMD_H$ - Teaching demand at H (expressed as a number of providers),

- $PRATE_{P,M}$ - Number of deliveries possible by P performing mission M,

- LN - Large number (ideally, this number should be as small as possible. 50 and 25 were used in this study for constraints (3.6) and (3.8) respectively).

The penalty costs stated above are arrived at through a repetitive trial-and-error process. The costs are gradually

increased until they reach a level that only permits the model to use elastic variables as a last option.

C. DECISION VARIABLES

- $X_{P,H,M}$ - Number of type P providers assigned to facility H for mission M (integer for the military assets/continuous for the civilian assets. In the implementation of the model, the integer variables are given reasonable upper bounds to improve the solve time. Additionally, the $X_{OBGYN,OCONUS,CLINICAL}$ variables are given lower bounds of three since these facilities must be staffed with three military OB/GYN physicians),
- $MTFOPEN_{CH}$ - Binary variable equal to 1 if the CONUS OB/GYN service remains open; 0 if it closes,
- $DEVC_H$ - Elastic variable used in the clinical demand constraint,
- $DEVT_T$ - Elastic variable used in the teaching demand constraint,
- $ELASTCHAMP_H$ - Elastic variable used in the constraint dealing with demand in excess of capacity.

D. OBJECTIVE FUNCTION

$$\begin{aligned} &\sum_P \sum_H \sum_M X_{P,H,M} * PRATE_{P,M} * COST_{P,H} \\ &+ \sum_H ELASTCHAMP_H * PRATE_{CHAMPUS,CLINICAL} * CHAMPCOST_H \\ &+ \sum_H DEVC_H * CLINCOST_H \\ &+ \sum_H DEVT_H * TEACHCOST_H \end{aligned} \tag{3.1}$$

This equation yields the annual operating costs (in thousands of dollars) of providing OB/GYN services plus penalties. The model minimizes this value.

E. CONSTRAINTS

$$\sum_{P}\sum_{M} X_{P,H,M} * PRATE_{P,M} \geq CLINDMD_{H} - DEVC_{H} \quad \forall H \qquad (3.2)$$

Constraint (3.2) elastically ensures that demand for clinical providers is met at each facility maintaining an OB/GYN service.

$$X_{OBGYN,H,TEACHING} + X_{PARTNER,H,TEACHING} + X_{CONTRACT,H,TEACHING} \geq TEACHDMD_{H} - DEVT_{H} \quad \forall H \qquad (3.3)$$

Constraint (3.3) elastically ensures that teaching demand is met at each facility operating a Graduate Medical Education program.

$$(X_{CHAMPUS,H,CLINICAL} + ELASTCHAMP_{H}) * PRATE_{CHAMPUS,CLINICAL} \geq CLINDMD_{H} - CAPAC_{H} \quad \forall H \qquad (3.4)$$

Constraint (3.4) ensures that demand in excess of physical capacity is absorbed by the CHAMPUS program. Use of the elastic variable in this constraint implies that there is not a sufficient supply of CHAMPUS providers to absorb the excess demand. In this case, available options are to recruit additional civilian (CHAMPUS) OB/GYN physicians into the area, or build additional physical capacity (i.e., construct new delivery rooms).

$$\sum_{H}\sum_{M} X_{N,H,M} \leq SUPP_{N} \quad \forall N \tag{3.5}$$

Constraint (3.5) ensures that the general provider supplies of Navy OB/GYN physicians and CNMs are not exceeded. The other provider types (i.e., military FP physicians, partnership OB/GYN physicians, contract OB/GYN physicians, and CHAMPUS OB/GYN physicians) have upper bounds on their supplies based on both provider and hospital. Appropriate syntax is used in the implementation of the model (Appendix E) to upper bound these other provider types.

$$\sum_{M} [X_{OBGYN,CH,M} + X_{CONTRACT,CH,M} + X_{PARTNER,CH,M}] \leq LN * MTFOPEN_{CH} \quad \forall CH \tag{3.6}$$

$$3 * MTFOPEN_{CH} \leq \sum_{M} [X_{OBGYN,CH,M} + X_{CONTRACT,CH,M} + X_{PARTNER,CH,M}] \quad \forall CH \tag{3.7}$$

Constraint (3.6) ensures that assets are assigned only if the facility's OB/GYN service remains open. Constraint (3.7) ensures that if facility's OB/GYN service is open there are at least three physicians assigned. These inequalities are examples of *minimum batch size constraints* [Ref. 16:p. 187].

$$X_{FAMPRAC,CH,CLINICAL} + X_{MIDWIFE,CH,CLINICAL} \leq LN * MTFOPEN_{CH} \quad \forall CH \tag{3.8}$$

Constraint (3.8) ensures that FP physicians and CNMs are not assigned to hospitals with a closed OB/GYN service.

The next chapter describes computational experience using the initial case of the model and nine different scenarios.

IV. COMPUTATIONAL EXPERIENCE

A. MODEL GENERATION AND SOLVE TIME

General Algebraic Modeling System (GAMS) [Ref. 17] is used to generate the model and it is solved using *XA* developed by *Sunset Software Technology* [Ref. 18].

The model is generated and solved on an *Amdahl 5990-500 mainframe*. The model consists of 240 constraints and 683 variables of which 399 are integer. CPU time for the test problems considered averages 2309 seconds, guaranteed within 2.5% of optimality (the maximum CPU time is 5540 seconds for the second scenario).

B. MODEL SOLUTION

As previously mentioned in Chapter III, there are general supplies of Navy OB/GYN physicians and Navy CNMs available for allocation. There are hospital-specific supplies of the other provider types (i.e., Navy FP physicians, contract OB/GYN physicians, partnership OB/GYN physicians, and CHAMPUS OB/GYN physicians -- see Appendix E, the *GAMS* formulation of the model, for these hospital-specific supply numbers).

In the initial case of the model, there are 86 Navy OB/GYN physicians and 11 CNMs available for allocation to the 35 Navy hospitals. Again, the objective is to minimize the annual

operating costs of delivering OB/GYN services plus penalties, subject to the constraints listed in the previous chapter.

The *GAMS* output from the initial case of the model is shown below. An explanation, in parentheses, precedes each report. In the reports, "C" represents clinician, and "T" represents teacher:

(This report illustrates the model's allocation of the CNMs, military OB/GYN physicians, and FP physicians to the CONUS facilities).

---- 701 PARAMETER REPORT1 CONUS MTF MILITARY ALLOCATION SUMMARY

	MIDWIFE	OB(C)	FP
BETHESDA		3.00	
CP-LEJEUNE	3.00	11.00	
CP-PDLTON		1.00	7.00
CHARLESTON		3.00	9.00
CHERRY-PT		3.00	5.00
JAX		1.00	9.00
OAK-HARBOR		3.00	
PAX-RIVER		3.00	
PENSACOLA			7.00
SAN-DIEGO		19.00	
TOTAL	3.00	47.00	37.00

(This report illustrates the model's allocation of the CHAMPUS, partnership, and contract OB/GYN physicians to the CONUS facilities).

---- 714 PARAMETER REPORT2 CONUS MTF CIVILIAN ALLOCATION SUMMARY

	CHAMPUS	PSHIP(C)	PSHIP(T)
BEAUFORT	3.84		
BETHESDA		0.52	12.00
BREMERTON	5.45		3.00
CP-LEJEUNE	1.00	0.67	
CP-PDLTON	6.93	1.39	7.00
CHARLESTON	3.11	1.22	10.00
CHERRY-PT		0.01	
CORP-CHRIS	1.74		
GT-LAKES	5.66		
GROTON	5.19		
JAX	6.30	0.72	7.00
LONG-BEACH	11.28		
MILLINGTON	3.83		
NEWPORT	2.72		
OAK-HARBOR	0.40		
OAKLAND	4.91		11.00
ORLANDO	3.67		
PENSACOLA	1.67		5.00
PHILLY	4.39		
PORTSMOUTH	34.68		14.00
SAN-DIEGO		5.40	14.00
TOTAL	106.76	9.93	83.00

(This report illustrates the model's allocation of the CNMs, military OB/GYN physicians, and FP physicians to the OCONUS/isolated facilities).

---- 725 PARAMETER REPORT3 OCONUS-ISOLATED MTF ALLOCATION SUMMARY

	MIDWIFE	OB(C)	FP
ADAK		3.00	
GUAM	1.00	3.00	3.00
GITMO-BAY		3.00	
KEFLAVIK		3.00	
LEMOORE		3.00	
NAPLES		3.00	
OKINAWA	5.00	3.00	2.00
ROOSEVELT		3.00	
ROTA		3.00	
SIGONELLA		3.00	
SUBIC-BAY	1.00	3.00	
TWTYNINE	1.00	3.00	
YOKOSUKA		3.00	
TOTAL	8.00	39.00	5.00

(This report illustrates the model's use of elastic variables to ensure feasibility, as explained in Chapter III. In this example, there is insufficient CHAMPUS assets to support Camp Lejeune's demand in excess of physical capacity. Ideally, the model wants to use 4.67 CHAMPUS providers for Camp Lejeune, but there is only one CHAMPUS OB/GYN physician available. Therefore, the elastic variable in the amount of 3.67 is used to satisfy the constraint).

---- 731 PARAMETER REPORT4 ELASTIC VARIABLE SUMMARY

	ELASTCHAMP
CP-LEJEUNE	3.67

(This report illustrates which CONUS OB/GYN services remain open, and which ones close. In addition to the facilities listed as open in this report, **all** 13 OCONUS/isolated OB/GYN services remain open. The report is edited to display the "OPEN" and "CLOSED" columns, and the "X" in the appropriate place. The actual GAMS report displays "1.0" for "OPEN" services and nothing for "CLOSED" services).

---- 736 PARAMETER REPORT5 MTF OBGYN SERVICE CLOSURE SUMMARY

	OPEN	CLOSED
BEAUFORT		X
BETHESDA	X	
BREMERTON	X	
CP-LEJEUNE	X	
CP-PDLTON	X	
CHARLESTON	X	
CHERRY-PT	X	
CORP-CHRIS		X
GT-LAKES		X
GROTON		X
JAX	X	
LONG-BEACH		X
MILLINGTON		X
NEWPORT		X
OAK-HARBOR	X	
OAKLAND	X	
ORLANDO		X
PAX-RIVER	X	
PENSACOLA	X	

PHILLY		X
PORTSMOUTH	X	
SAN-DIEGO	X	

39 of the 86 military OB/GYN physicians get assigned to the OCONUS/isolated facilities. These facilities cannot be closed, and must be staffed with at least three military OB/GYN physicians. The total numbers of providers allocated to CONUS hospitals are in close agreement with current staffing [Ref. 3], however, the mix of providers suggested by the model is often different. For example, Naval Hospital Bethesda is currently staffed by 15 military OB/GYN physicians. The model says to allocate 15.52 OB/GYN physicians to this facility, but 12.52 of them are civilian partnership physicians. The use of alternative provider types is strongly suggested by the model, as illustrated by the allocation of 11 CNMs, 42 FP physicians, and 92.93 partnership physicians. Contract physicians did not appear in the recommended solution because the assumed cost structure prefers partnership physicians to contract physicians in all areas. In reality, some areas may have the ability to obtain contract services at lower cost than partnership services, and in these cases, contract providers would be substituted for the partnership providers.

The model recommends closing the OB/GYN service at the following hospitals:

- Beaufort, SC,
- Corpus Christi, TX,
- Great Lakes, IL,
- Groton, CT,
- Long Beach, CA,
- Millington, TN,
- Newport, RI,
- Orlando, FL,
- Philadelphia, PA.

Rather than staff these facilities with at least three physicians and keep them open, it is more cost-effective to close the service, and refer all demand to civilian sources of care.

C. SENSITIVITY ANALYSIS

Nine runs of the model, in addition to the initial case, are conducted to examine the sensitivity of changing various components of the model. A description of each of these sensitivity analysis runs is as follows:

- In this run, the military OB/GYN physician level is reduced to the projected FY-97 worst case scenario of 65. The military CNM level remains at 11. The impact of this is evident in the allocations to the CONUS hospitals. The OCONUS/isolated facilities continue to receive 39 of the physicians because staffing of these 13 hospitals with at least three military OB/GYN physicians is a hard constraint. Therefore, the CONUS allocation of military OB/GYN physicians is reduced from 47 to 26, and the

shortfall is made up by an increase in partnership physicians from 92.93 to 115.26.

- In this run, the military OB/GYN physician level is increased to the billets authorized level of 113. The military CNM level remains at 11. The allocation of military OB/GYN physicians to CONUS facilities is increased from 47 to 74. Use of partnership assets decreases from 92.93 to 66.93.

- In this run, military OB/GYN physicians are reduced to 65, and CNMs are increased to the projected FY-94 level of 20. As before, allocation of military OB/GYN physicians to CONUS hospitals decreases from 47 to 26. The use of CNMs at Camp Lejeune increases dramatically from three to 13. Use of partnership assets increases from 92.93 to 106.26. Additionally, one contract physician is used at Camp Lejeune.

- In this run, military OB/GYN physicians remain at the initial case level of 86, and CNMs are increased to 20. The large increase of CNM use at Camp Lejeune is again evident. A part-time contract physician is allocated to Camp Lejeune (0.33 full-time equivalents). Partnership physicians are reduced from 92.93 to 88.26.

- In this run, military OB/GYN physicians are increased to 113, and CNMs are increased to 20. Again, Camp Lejeune's use of CNMs increases from three to 13. Allocation of military OB/GYN physicians to CONUS hospitals increases from 47 to 74. One contract physician is used at Camp Lejeune. Partnership asset use decreases from 92.93 to 60.65.

- In this run, delivery rooms are opened at facilities that currently do not have rooms in service. This did not result in any significant changes. In fact, the facilities considered in this run still are closed by the model, and all their demand is directed to the CHAMPUS program.

- In this run, the teaching requirement is relaxed. The use of FP physicians at CONUS facilities is significantly reduced from 37 to 12. The use of CHAMPUS increases from 106.76 to 136.26. The use of partnership physicians is greatly reduced from 92.93 to 9.82. The most dramatic result is the change in the open/closed summary report. Bremerton, Camp Pendleton, Charleston, Jacksonville, Oakland, and Portsmouth are now added to the closure report increasing the number of closed CONUS OB/GYN services from nine to 15.

- In this run, supplies of CHAMPUS, contract, and partnership physicians at Camp Lejeune are increased from one to ten. In previous runs, Camp Lejeune always generates 3.67 units of the elastic variable $ELASTCHAMP_H$ because the model wants to use CHAMPUS providers to meet this facility's demand, but there is only one CHAMPUS physician available. By increasing the availble supply to ten physicians, Camp Lejeune uses all ten CHAMPUS providers increasing CHAMPUS use from 106.76 to 114.76 (i.e., even though Camp Lejeune's CHAMPUS use increases by nine, overall CHAMPUS use only increases by eight, because Pensacola's CHAMPUS use decreases by one). In the CONUS allocations, 47 military OB/GYN physicians are still assigned, but now 12 of them are designated as teachers. Partnership asset use decreases from 92.93 to 86.26. Additionally, the model no longer incurs any penalty costs.

- In this run, the relative ordering of the costs assumed to be *CNM < FP < partnership < contract* in the initial case, is changed to *partnership < contract < CNM < FP*. In the CONUS allocations, FP physicians are no longer assigned. The military OB/GYN providers assigned to the CONUS facilities decrease from 47 to 14. CHAMPUS use decreases from 106.76 to 90.19. Partnership use increases significantly from 92.93 to 155.16. One contract physician is allocated to Camp Lejeune.

The percentage changes in the objective function value (true costs + penalties) for each scenario as compared to the initial case are displayed in Table V.

TABLE V. PERCENTAGE CHANGE IN OBJECTIVE FUNCTION VALUE

SCENARIO	PERCENTAGE CHANGE
OB/GYNs = 65 & CNMs = 11	0.42%
OB/GYNs = 113 & CNMs = 11	-0.22%
OB/GYNs = 65 & CNMs = 20	-1.09%
OB/GYNs = 86 & CNMs = 20	-1.23%
OB/GYNs = 113 & CNMs = 20	-1.27%
New delivery rooms opened	0.94%
Teaching constraint relaxed	0.08%
Camp Lejeune supplies increased	-3.21%
Ordering of costs changed	-10.04%

One important note is the fact that in every sensitivity analysis run, with the exception of the scenario that relaxes the teaching requirement, the same facilities are recommended for open and closed status. The output of these sensitivity analyses are provided as Appendices F, G, H, I, J, K, L, M, and N.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The following conclusions are drawn as a result of perfoming this research:

- Mathematical programming can be used as a tool to assist Navy medical manpower planners in devising an OB/GYN staffing plan.
- In order to continue operating Graduate Medical Education programs at the teaching facilities, a cost is incurred resulting from the requirement to keep more OB/GYN services open, and by the need to integrate civilian OB/GYN physicians (i.e., contract and partnership) into the allocation plan.
- In order to implement the policy of staffing OCONUS/isolated facilities with three or more military OB/GYN physicians, a cost is incurred resulting from the requirement to integrate civilian OB/GYN assets into the CONUS facilities remaining open.

In summary, if the supply of military OB/GYN physicians continues to dwindle, or is required for certain constraints (i.e., staffing OCONUS/isolated hospitals with at least three physicians, meeting GME requirements, etc.), the additional constraints, mainly meeting clinical demand at the CONUS hospitals remaining open, must be met by alternative provider types -- CNMS, FP physicians, partnership physicians, contract physicians, etc.

The model developed in this thesis attempts to provide insight into the optimal allocation mix of these alternatives.

B. RECOMMENDATIONS

The following recommendations are provided:

- The current total cost per delivery data inputs to the model are not accurate. These numbers are assumed due to the lack of existing data. It is strongly recommended that data collection systems be developed to accurately track cost data. This would add validity to the allocations suggested by the model solution, enabling this model to be used more reliably as a decision-making tool.

- Due to the lack of supporting data, not all OB/GYN alternatives are modeled in this thesis. It is recommended, again, that required data be tracked, so that options such as reservists, government civil service OB/GYN physicians, FP Nurse Practitioners, OB/GYN Nurse Practitioners, etc. can be added to the model.

- Demand in this model is simply assumed to be the summation of CHAMPUS and direct care deliveries experienced by a facility for a particular time period (FY-90 in this study). Perhaps, a more accurate definition of demand can be devised that incorporates more of, if not all, the OB/GYN workload procedures. As yet another alternative, demand can be based on the demographics of the population in a facility's location, versus basing the demand on historical workload.

- The routines developed in this thesis could possibly be improved. As an example, by setting the large number, LN, used in two of the model's constraints as small as possible, the solve time could probably be reduced.

APPENDIX A - FY90 STATISTICS (CONUS)

MTF	OPERATING BEDS	ADMISSIONS	OUTPATIENT VISITS
Beaufort	57	2,480	97,863
Bethesda	455	17,137	440,314
Bremerton	111	4,824	215,930
Camp Lejeune	167	8,804	252,308
Camp Pendleton	128	9,036	289,861
Charleston	179	10,027	256,039
Cherry Point	43	2,713	167,628
Corpus Christi	50	1,896	93,644
Great Lakes	153	4,043	289,437
Groton	27	1,838	171,953
Jacksonville	103	10,133	275,311
Long Beach	151	3,874	135,562
Millington	66	3,169	135,370
Newport	59	2,375	140,980
Oak Harbor	23	1,960	125,509
Oakland	225	12,001	269,100
Orlando	143	5,999	187,871
Patuxent River	20	1,205	91,999
Pensacola	104	5,924	236,194
Philadelphia	21	2,168	115,696
Portsmouth	495	28,805	624,270
San Diego	396	29,193	618,309

APPENDIX B - FY90 STATISTICS (OCONUS/ISOLATED)

MTF	OPERATING BEDS	ADMISSIONS	OUTPATIENT VISITS
Adak	15	607	42,869
Guam	55	4,246	126,632
Guantanamo Bay	11	1,231	45,503
Keflavik	17	623	34,778
Lemoore	27	1,555	110,409
Naples	26	2,591	56,518
Okinawa	104	7,136	162,452
Roosevelt Roads	35	2,100	76,617
Rota	52	2,271	98,350
Sigonella	4	359	39,347
Subic Bay	86	3,807	138,635
29 Palms	17	2,171	117,016
Yokosuka	110	3,835	119,606

APPENDIX C - FY90 DEMAND (CONUS)

MTF	CHAMPUS	DIRECT CARE	TOTAL
Beaufort	379	312	691
Bethesda	78	1,155	1,233
Bremerton	491	640	1,131
Camp Lejeune	1,745	895	2,640
Camp Pendleton	1,297	1,151	2,448
Charleston	1,088	1,272	2,360
Cherry Point	53	789	842
Corpus Christi	313	0	313
Great Lakes	989	29	1,018
Groton	934	0	934
Jacksonville	1,345	989	2,334
Long Beach	2,030	0	2,030
Millington	227	462	689
Newport	490	0	490
Oak Harbor	117	495	612
Oakland	249	1,184	1,433
Orlando	58	602	660
Patuxent River	18	298	316
Pensacola	292	679	971
Philadelphia	790	0	790
Portsmouth	4,486	2,457	6,943
San Diego	1,604	3,488	5,092

APPENDIX D - FY90 DEMAND (OCONUS/ISOLATED)

MTF	CHAMPUS	DIRECT CARE	TOTAL
Adak	1	108	109
Guam	0	819	819
Guantanamo Bay	0	106	106
Keflavik	0	119	119
Lemoore	184	296	480
Naples	0	395	395
Okinawa	0	1,199	1,199
Roosevelt Roads	7	243	250
Rota	0	248	248
Sigonella	0	0	0
Subic Bay	0	613	613
29 Palms	25	550	575
Yokosuka	0	492	492

APPENDIX E - GAMS FORMULATION OF MODEL

```
$TITLE Optimal Allocation Model for OBGYN Provider Assets
$STITLE
*
* By: Michael S. Schaffer
* Date: 13 August 1992
*
* THIS MODEL IS A MIXED INTEGER LINEAR PROGRAMMING MODEL THAT EXAMINES
* THE NAVY MEDICAL DEPARTMENT'S OBGYN PHYSICIAN STAFFING PROBLEM BY
* OPTIMALLY ASSIGNING THE FOLLOWING PROVIDER TYPES: MILITARY OBGYN
* PHYSICIANS, MILITARY FAMILY PRACTICE PHYSICIANS, MILITARY CERTIFIED
* NURSE MIDWIVES, CIVILIAN PARTNERSHIP OBGYN PHYSICIANS, CIVILIAN
* CONTRACT OBGYN PHYSICIANS, AND CHAMPUS OBGYN PHYSICIANS.  IN THE CASE
* OF HOSPITALS THAT ARE IN THE UNITED STATES (CONUS) AND NOT ISOLATED,
* THE MODEL CAN DECIDE TO CLOSE THE FACILITY'S OBGYN SERVICE, RATHER
* THAN ASSIGN ASSETS TO IT.  IN THE CASE OF HOSPITALS THAT ARE OVERSEAS
* (OCONUS) OR ISOLATED, CLOSURE OF THE OBGYN SERVICE IS NOT PERMITTED,
* I.E., THE SERVICE MUST BE STAFFED.  THE MODEL EMPLOYS ELASTIC
* VARIABLES AND ASSOCIATED PENALTY COSTS TO ENSURE A FEASIBLE SOLUTION.
*
*------------------GAMS AND DOLLAR CONTROL OPTIONS----------------------
*                    (SEE APPENDICES B & C)
$OFFUPPER OFFSYMLIST OFFSYMXREF
*
OPTIONS
    LIMCOL = 0 , LIMROW = 0 , SOLPRINT = OFF , DECIMALS = 2
    RESLIM = 36000 , ITERLIM = 100000 , OPTCR = 0.025 ;
*
*----------------------DEFINITIONS AND DATA-----------------------------
*
* ---- Define index sets.
*
 SETS
    H    all Navy military treatment facilities (MTFs)
         /ADAK
          BEAUFORT
          BETHESDA
          BREMERTON
          CP-LEJEUNE
          CP-PDLTON
          CHARLESTON
          CHERRY-PT
          CORP-CHRIS
          GT-LAKES
          GROTON
          GUAM
          GITMO-BAY
          JAX
          KEFLAVIK
          LEMOORE
          LONG-BEACH
          MILLINGTON
          NAPLES
          NEWPORT
          OAK-HARBOR
          OAKLAND
          OKINAWA
          ORLANDO
          PAX-RIVER
          PENSACOLA
          PHILLY
```

```
          PORTSMOUTH
          ROOSEVELT
          ROTA
          SAN-DIEGO
          SIGONELLA
          SUBIC-BAY
          TWTYNINE
          YOKOSUKA/
*
    CONUS(H)    Navy MTFs that are not classified as OCONUS or isolated
                /BEAUFORT
                 BETHESDA
                 BREMERTON
                 CP-LEJEUNE
                 CP-PDLTON
                 CHARLESTON
                 CHERRY-PT
                 CORP-CHRIS
                 GT-LAKES
                 GROTON
                 JAX
                 LONG-BEACH
                 MILLINGTON
                 NEWPORT
                 OAK-HARBOR
                 OAKLAND
                 ORLANDO
                 PAX-RIVER
                 PENSACOLA
                 PHILLY
                 PORTSMOUTH
                 SAN-DIEGO/
*
    OCONUS(H)   Navy MTFs that are classified as OCONUS or isolated
                /ADAK
                 GUAM
                 GITMO-BAY
                 KEFLAVIK
                 LEMOORE
                 NAPLES
                 OKINAWA
                 ROOSEVELT
                 ROTA
                 SIGONELLA
                 SUBIC-BAY
                 TWTYNINE
                 YOKOSUKA/
*
    M    primary mission of OBGYN physician
         /CLINICAL
          TEACHING/
*
    P1   military healthcare provider types
         /OBGYN
          FAMPRAC
          MIDWIFE/
*
    P2   civilian healthcare provider types
         /CHAMPUS
          CONTRACT
          PARTNER/ ;
*
* ---- Data entry: all cost data in dollars (000).
*
 PARAMETERS
*
    CHAMSUPPLY(CONUS)     supply of CHAMPUS OBGYN physicians
*                         available in MTF CONUS(H) catchment area
```

```
                        /BEAUFORT       14
                         BETHESDA      810
                         BREMERTON      23
                         CP-LEJEUNE      1
                         CP-PDLTON      32
                         CHARLESTON     67
                         CHERRY-PT      13
                         CORP-CHRIS     31
                         GT-LAKES      450
                         GROTON         80
                         JAX           104
                         LONG-BEACH    701
                         MILLINGTON     90
                         NEWPORT        94
                         OAK-HARBOR      3
                         OAKLAND       357
                         ORLANDO        85
                         PAX-RIVER       0
                         PENSACOLA      34
                         PHILLY        326
                         PORTSMOUTH    161
                         SAN-DIEGO     153/
*
    PSHIPSPPLY(CONUS)     supply of partnership OBGYN physicians
*                         available in MTF CONUS(H) catchment area
                        /BEAUFORT       14
                         BETHESDA      810
                         BREMERTON      23
                         CP-LEJEUNE      1
                         CP-PDLTON      32
                         CHARLESTON     67
                         CHERRY-PT      13
                         CORP-CHRIS     31
                         GT-LAKES      450
                         GROTON         80
                         JAX           104
                         LONG-BEACH    701
                         MILLINGTON     90
                         NEWPORT        94
                         OAK-HARBOR      3
                         OAKLAND       357
                         ORLANDO        85
                         PAX-RIVER       0
                         PENSACOLA      34
                         PHILLY        326
                         PORTSMOUTH    161
                         SAN-DIEGO     153/
*
    CONTRSPPLY(CONUS)     supply of contract OBGYN physicians
*                         available in MTF CONUS(H) catchment area
                        /BEAUFORT       14
                         BETHESDA      810
                         BREMERTON      23
                         CP-LEJEUNE      1
                         CP-PDLTON      32
                         CHARLESTON     67
                         CHERRY-PT      13
                         CORP-CHRIS     31
                         GT-LAKES      450
                         GROTON         80
                         JAX           104
                         LONG-BEACH    701
                         MILLINGTON     90
                         NEWPORT        94
                         OAK-HARBOR      3
                         OAKLAND       357
                         ORLANDO        85
                         PAX-RIVER       0
```

```
                    PENSACOLA      34
                    PHILLY        326
                    PORTSMOUTH    161
                    SAN-DIEGO     153/
*
    FPSUPPLY(H)     supply of military Family Practice physicians at MTF
*                   H that can be used to augment OBGYN services
                   /ADAK           1
                    BEAUFORT       0
                    BETHESDA       0
                    BREMERTON      6
                    CP-LEJEUNE     0
                    CP-PDLTON      8
                    CHARLESTON    10
                    CHERRY-PT      9
                    CORP-CHRIS     3
                    GT-LAKES       0
                    GROTON         0
                    GUAM          11
                    GITMO-BAY      2
                    JAX            9
                    KEFLAVIK       3
                    LEMOORE        4
                    LONG-BEACH     3
                    MILLINGTON     6
                    NAPLES         5
                    NEWPORT       15
                    OAK-HARBOR     6
                    OAKLAND        0
                    OKINAWA        7
                    ORLANDO        3
                    PAX-RIVER      6
                    PENSACOLA      8
                    PHILLY         2
                    PORTSMOUTH     0
                    ROOSEVELT      2
                    ROTA           5
                    SAN-DIEGO      0
                    SIGONELLA      0
                    SUBIC-BAY      3
                    TWTYNINE       4
                    YOKOSUKA       2/
*
    DELROOM(H)      number of delivery rooms in use at MTF H
                   /ADAK           1
                    BEAUFORT       2
                    BETHESDA       5
                    BREMERTON      2
                    CP-LEJEUNE     3
                    CP-PDLTON      2
                    CHARLESTON     3
                    CHERRY-PT      2
                    CORP-CHRIS     0
                    GT-LAKES       0
                    GROTON         0
                    GUAM           2
                    GITMO-BAY      3
                    JAX            2
                    KEFLAVIK       1
                    LEMOORE        2
                    LONG-BEACH     0
                    MILLINGTON     2
                    NAPLES         2
                    NEWPORT        0
                    OAK-HARBOR     1
                    OAKLAND        5
                    OKINAWA        2
                    ORLANDO        2
```

```
                    PAX-RIVER      1
                    PENSACOLA      2
                    PHILLY         0
                    PORTSMOUTH     4
                    ROOSEVELT      2
                    ROTA           2
                    SAN-DIEGO     12
                    SIGONELLA      0
                    SUBIC-BAY      2
                    TWTYNINE       1
                    YOKOSUKA       2/
*
    ECHAMPCOST(H)   penalty cost for using elastic variable ELASTCHAMP
*                   (1.5 times the CHAMPUS cost)
                   /ADAK           0
                    BEAUFORT       1.527510
                    BETHESDA       2.915265
                    BREMERTON      1.972665
                    CP-LEJEUNE     1.957035
                    CP-PDLTON      2.145150
                    CHARLESTON     2.061285
                    CHERRY-PT      4.645095
                    CORP-CHRIS     2.161065
                    GT-LAKES       2.161065
                    GROTON         2.161065
                    GUAM             0
                    GITMO-BAY        0
                    JAX            2.944935
                    KEFLAVIK         0
                    LEMOORE          0
                    LONG-BEACH     2.161065
                    MILLINGTON     1.660020
                    NAPLES           0
                    NEWPORT        2.161065
                    OAK-HARBOR     1.090785
                    OAKLAND        1.631715
                    OKINAWA          0
                    ORLANDO        2.161065
                    PAX-RIVER      2.718420
                    PENSACOLA      2.265570
                    PHILLY         2.161065
                    PORTSMOUTH     1.379370
                    ROOSEVELT        0
                    ROTA             0
                    SAN-DIEGO      1.501230
                    SIGONELLA        0
                    SUBIC-BAY        0
                    TWTYNINE         0
                    YOKOSUKA         0/
*
    SUP(P1)      supply of provider types
                /OBGYN    86
                 MIDWIFE  11/ ;
*
    SCALAR USAGE  deliveries per delivery room per year /600/ ;
*
    PARAMETER   CAPAC(H)  deliveries per year that can be done at MTF H ;
                CAPAC(H) = USAGE * DELROOM(H) ;
*
    TABLE MILCOST(H,P1)     cost per delivery performed by provider type
*                           P1 at MTF H
                     OBGYN    FAMPRAC  MIDWIFE
         ADAK       1.34941  1.07953  0.87712
         BEAUFORT   1.19180  0.95344  0.77467
         BETHESDA   1.47300  1.17840  0.95745
         BREMERTON  1.81089  1.44871  1.17708
         CP-LEJEUNE 1.74378  1.39502  1.13346
         CP-PDLTON  1.28385  1.02708  0.83450
```

```
        CHARLESTON 1.27956  1.02365  0.83171
        CHERRY-PT  1.91438  1.53150  1.24435
        CORP-CHRIS 1.51386  1.21109  0.98401
        GT-LAKES   1.51386  1.21109  0.98401
        GROTON     1.51386  1.21109  0.98401
        GUAM       1.03759  0.83007  0.67443
        GITMO-BAY  1.63352  1.30682  1.06179
        JAX        1.49081  1.19265  0.96903
        KEFLAVIK   1.51386  1.21109  0.98401
        LEMOORE    1.02742  0.82194  0.66782
        LONG-BEACH 1.51386  1.21109  0.98401
        MILLINGTON 1.23792  0.99034  0.80465
        NAPLES     2.05509  1.64407  1.33581
        NEWPORT    1.51386  1.21109  0.98401
        OAK-HARBOR 0.91534  0.73227  0.59497
        OAKLAND    1.79893  1.43914  1.16930
        OKINAWA    2.79053  2.23242  1.81384
        ORLANDO    1.63511  1.30809  1.06282
        PAX-RIVER  1.90613  1.52490  1.23898
        PENSACOLA  1.46621  1.17297  0.95304
        PHILLY     1.51386  1.21109  0.98401
        PORTSMOUTH 1.35557  1.08446  0.88112
        ROOSEVELT  1.75826  1.40661  1.14287
        ROTA       1.06115  0.84892  0.68975
        SAN-DIEGO  0.91382  0.73106  0.59398
        SIGONELLA  1.51386  1.21109  0.98401
        SUBIC-BAY  1.44668  1.15734  0.94034
        TWTYNINE   1.51386  1.21109  0.98401
        YOKOSUKA   1.78358  1.42686  1.15933 ;
*
    TABLE CIVCOST(H,P2)      cost per delivery performed by provider type
*                            P2 at MTF H
                    CHAMPUS  CONTRACT  PARTNER
        ADAK          NA       NA       NA
        BEAUFORT   1.01834  1.31098  1.25139
        BETHESDA   1.94351  1.62030  1.54665
        BREMERTON  1.31511  1.99198  1.90143
        CP-LEJEUNE 1.30469  1.91816  1.83097
        CP-PDLTON  1.43010  1.41223  1.34804
        CHARLESTON 1.37419  1.40752  1.34354
        CHERRY-PT  3.09673  2.10582  2.01010
        CORP-CHRIS 1.44071  1.66525  1.58955
        GT-LAKES   1.44071  1.66525  1.58955
        GROTON     1.44071  1.66525  1.58955
        GUAM          NA       NA       NA
        GITMO-BAY     NA       NA       NA
        JAX        1.96329  1.63989  1.56535
        KEFLAVIK      NA       NA       NA
        LEMOORE       NA       NA       NA
        LONG-BEACH 1.44071  1.66525  1.58955
        MILLINGTON 1.10668  1.36171  1.29982
        NAPLES        NA       NA       NA
        NEWPORT    1.44071  1.66525  1.58955
        OAK-HARBOR 0.72719  1.00687  0.96111
        OAKLAND    1.08781  1.97882  1.88888
        OKINAWA       NA       NA       NA
        ORLANDO    1.44071  1.79862  1.71687
        PAX-RIVER  1.81228  2.09674  2.00144
        PENSACOLA  1.51038  1.61283  1.53952
        PHILLY     1.44071  1.66525  1.58955
        PORTSMOUTH 0.91958  1.49113  1.42335
        ROOSEVELT     NA       NA       NA
        ROTA          NA       NA       NA
        SAN-DIEGO  1.00082  1.00520  0.95951
        SIGONELLA     NA       NA       NA
        SUBIC-BAY     NA       NA       NA
        TWTYNINE      NA       NA       NA
        YOKOSUKA      NA       NA       NA ;
```

```
*
 PARAMETERS
*
    CLINDMD(H)       demand at MTF H for providers performing
*                    a clinical mission (# of deliveries)
                    /ADAK                    109
                     BEAUFORT                691
                     BETHESDA               1233
                     BREMERTON              1131
                     CP-LEJEUNE             2640
                     CP-PDLTON              2448
                     CHARLESTON             2360
                     CHERRY-PT               842
                     CORP-CHRIS              313
                     GT-LAKES               1018
                     GROTON                  934
                     GUAM                    819
                     GITMO-BAY               106
                     JAX                    2334
                     KEFLAVIK                119
                     LEMOORE                 480
                     LONG-BEACH             2030
                     MILLINGTON              689
                     NAPLES                  395
                     NEWPORT                 490
                     OAK-HARBOR              612
                     OAKLAND                1433
                     OKINAWA                1199
                     ORLANDO                 660
                     PAX-RIVER               316
                     PENSACOLA               971
                     PHILLY                  790
                     PORTSMOUTH             6943
                     ROOSEVELT               250
                     ROTA                    248
                     SAN-DIEGO              5092
                     SIGONELLA                 0
                     SUBIC-BAY               613
                     TWTYNINE                575
                     YOKOSUKA                492/
*
    TEACHDMD(H)      demand at MTF H for providers performing
*                    a teaching mission (# of providers)
                    /ADAK                      0
                     BEAUFORT                  0
                     BETHESDA                 12
                     BREMERTON                 3
                     CP-LEJEUNE                0
                     CP-PDLTON                 7
                     CHARLESTON               10
                     CHERRY-PT                 0
                     CORP-CHRIS                0
                     GT-LAKES                  0
                     GROTON                    0
                     GUAM                      0
                     GITMO-BAY                 0
                     JAX                       7
                     KEFLAVIK                  0
                     LEMOORE                   0
                     LONG-BEACH                0
                     MILLINGTON                0
                     NAPLES                    0
                     NEWPORT                   0
                     OAK-HARBOR                0
                     OAKLAND                  11
                     OKINAWA                   0
                     ORLANDO                   0
                     PAX-RIVER                 0
```

```
                    PENSACOLA                   5
                    PHILLY                      0
                    PORTSMOUTH                 14
                    ROOSEVELT                   0
                    ROTA                        0
                    SAN-DIEGO                  14
                    SIGONELLA                   0
                    SUBIC-BAY                   0
                    TWTYNINE                    0
                    YOKOSUKA                    0/
*
    EDMDCOST(H)      penalty cost for using elastic variable
*                    CLINUNFILL
                    /ADAK                       50
                     BEAUFORT                   50
                     BETHESDA                   50
                     BREMERTON                  50
                     CP-LEJEUNE                 50
                     CP-PDLTON                  50
                     CHARLESTON                 50
                     CHERRY-PT                  50
                     CORP-CHRIS                 50
                     GT-LAKES                   50
                     GROTON                     50
                     GUAM                       50
                     GITMO-BAY                  50
                     JAX                        50
                     KEFLAVIK                   50
                     LEMOORE                    50
                     LONG-BEACH                 50
                     MILLINGTON                 50
                     NAPLES                     50
                     NEWPORT                    50
                     OAK-HARBOR                 50
                     OAKLAND                    50
                     OKINAWA                    50
                     ORLANDO                    50
                     PAX-RIVER                  50
                     PENSACOLA                  50
                     PHILLY                     50
                     PORTSMOUTH                 50
                     ROOSEVELT                  50
                     ROTA                       50
                     SAN-DIEGO                  50
                     SIGONELLA                  50
                     SUBIC-BAY                  50
                     TWTYNINE                   50
                     YOKOSUKA                   50/
*
    EGMECOST(H)      penalty cost for using elastic variable
*                    TCHUNFILL
                    /ADAK                     1000
                     BEAUFORT                 1000
                     BETHESDA                 1000
                     BREMERTON                1000
                     CP-LEJEUNE               1000
                     CP-PDLTON                1000
                     CHARLESTON               1000
                     CHERRY-PT                1000
                     CORP-CHRIS               1000
                     GT-LAKES                 1000
                     GROTON                   1000
                     GUAM                     1000
                     GITMO-BAY                1000
                     JAX                      1000
                     KEFLAVIK                 1000
                     LEMOORE                  1000
                     LONG-BEACH               1000
```

```
                    MILLINGTON                  1000
                    NAPLES                      1000
                    NEWPORT                     1000
                    OAK-HARBOR                  1000
                    OAKLAND                     1000
                    OKINAWA                     1000
                    ORLANDO                     1000
                    PAX-RIVER                   1000
                    PENSACOLA                   1000
                    PHILLY                      1000
                    PORTSMOUTH                  1000
                    ROOSEVELT                   1000
                    ROTA                        1000
                    SAN-DIEGO                   1000
                    SIGONELLA                   1000
                    SUBIC-BAY                   1000
                    TWTYNINE                    1000
                    YOKOSUKA                    1000/ ;
*
 PARAMETER TEACH(H)  1 if teaching demand exists at MTF H ;
    TEACH(H) = 1 $ (TEACHDMD(H) GT 0) ;
*
 SET
    MILOK(P1,H,M)   allowable military P1HM assignments ;
                    MILOK("OBGYN",H,"CLINICAL") = YES ;
                    MILOK("OBGYN",H,"TEACHING") = YES $ (TEACH(H) = 1) ;
                    MILOK("FAMPRAC",H,"CLINICAL") = YES ;
                    MILOK("MIDWIFE",H,"CLINICAL") = YES ;
*
 SET
    CIVOK(P2,H,M)   allowable civilian P2HM assignments ;
                    CIVOK("CHAMPUS",CONUS,"CLINICAL") = YES ;
                    CIVOK("CONTRACT",CONUS,"CLINICAL") = YES ;
                    CIVOK("CONTRACT",CONUS,"TEACHING") =
                    YES $ (TEACH(CONUS) = 1) ;
                    CIVOK("PARTNER",CONUS,"CLINICAL") = YES ;
                    CIVOK("PARTNER",CONUS,"TEACHING") =
                    YES $ (TEACH(CONUS) = 1) ;
*
    TABLE P1RATE(P1,M)     productivity level of provider type P1
*                          performing mission M
                                CLINICAL                TEACHING
          OBGYN                   180                     50
          FAMPRAC                  60                     NA
          MIDWIFE                 120                     NA ;
*
    TABLE P2RATE(P2,M)     productivity level of provider type P2
*                          performing mission M
                                CLINICAL                TEACHING
          CHAMPUS                 180                     NA
          CONTRACT                180                     50
          PARTNER                 180                     50 ;
*
*------------------VARIABLES, EQUATIONS, AND MODEL----------------------
*
    VARIABLES
      X(P1,H,M)       no. of type P1 providers to MTF H for mission M
      Y(P2,H,M)       no. of type P2 providers to MTF H for mission M
      MTFOPEN(CONUS) binary with 1 if service open and 0 if closed
      CLINUNFILL(H)  elastic variable for clinical demand equation
      TCHUNFILL(H)   elastic variable for teaching demand equation
      ELASTCHAMP(H)  elastic variable for capacity equation
      Z1             total true costs per year in thousands of dollars
      Z2             total penalty costs per year in thousands of dollars
      Z3             total true & penalty costs per year in thousands ;
*
    POSITIVE VARIABLE Y, CLINUNFILL, TCHUNFILL, ELASTCHAMP ;
    INTEGER VARIABLE X ;
```

```
    BINARY VARIABLE MTFOPEN ;
*
    X.UP("FAMPRAC",H,"CLINICAL") = FPSUPPLY(H) ;
    Y.UP("CHAMPUS",CONUS,"CLINICAL") = CHAMSUPPLY(CONUS) ;
    Y.UP("CONTRACT",CONUS,M) = CONTRSPPLY(CONUS) ;
    Y.UP("PARTNER",CONUS,M) = PSHIPSPPLY(CONUS) ;
    X.LO("OBGYN",OCONUS,"CLINICAL") = 3 ;
    X.UP("OBGYN",OCONUS,M) = 5 ;
    X.UP("OBGYN",CONUS,M) = 15 ;
    X.UP("OBGYN","SAN-DIEGO",M) = 40 ;
    X.UP("MIDWIFE",H,"CLINICAL") = 11 ;
*
    EQUATIONS
        TOTCOST             define total objective function
        TRUECOST            define part of objective that is not penalty
        PENCOST             define part of objective that is penalty
        CLINDEM(H)          meet clinical demand at MTF H
        TEACHDEM(H)         meet teaching demand at MTF H
        OVERCAP(H)          observe physical capacity at MTF H
        SUPPLY(P1)          observe supplies of provider type P1
        STAFFSHOPA(CONUS)   staff MTF CONUS(H) with 3+ OBGYNs or close it
        STAFFSHOPB(CONUS)   staff MTF CONUS(H) with 3+ OBGYNs or close it
        EXTENDER(CONUS)     do not assign extenders to closed MTF ;
*
 TOTCOST ..         Z3 =E= Z1 + Z2 ;
```

(NOTE: TRUECOST & PENCOST are accounting constraints. By combining these two constraints into one constraint, the solve time for the model could probably be reduced).

```
*
 TRUECOST ..        Z1 =E= SUM((H,P1,M) $ MILOK(P1,H,M), MILCOST(H,P1)
                        * X(P1,H,M) * P1RATE(P1,M)) + SUM((H,P2,M) $
                        CIVOK(P2,H,M), CIVCOST(H,P2) * Y(P2,H,M) *
                        P2RATE(P2,M)) ;
*
 PENCOST ..         Z2 =E= SUM(H, ECHAMPCOST(H) * ELASTCHAMP(H)
                        * P2RATE("CHAMPUS","CLINICAL"))
                        +  SUM(H, EDMDCOST(H) * CLINUNFILL(H))
                        +  SUM(H, EGMECOST(H) * TCHUNFILL(H)) ;
*
 CLINDEM(H) $ CLINDMD(H) ..
                    SUM((M,P1) $ MILOK(P1,H,M), X(P1,H,M) *
                    P1RATE(P1,M)) + SUM((M,P2) $ CIVOK(P2,H,M),
                    Y(P2,H,M) * P2RATE(P2,M)) + CLINUNFILL(H)
                    =G= CLINDMD(H) ;
*
 TEACHDEM(H) $ TEACHDMD(H) ..
                          X("OBGYN",H,"TEACHING")
                        + Y("PARTNER",H,"TEACHING")
                        + Y("CONTRACT",H,"TEACHING")
                        + TCHUNFILL(H) =G= TEACHDMD(H) ;
*
 OVERCAP(H) $ ((CLINDMD(H) - CAPAC(H)) GT 0) ..
          (P2RATE("CHAMPUS","CLINICAL") * Y("CHAMPUS",H,"CLINICAL"))
          + (P2RATE("CHAMPUS","CLINICAL")  *
          ELASTCHAMP(H)) =G= (CLINDMD(H) - CAPAC(H)) ;
*
 SUPPLY(P1) $ SUP(P1) ..    SUM((H,M) $ MILOK(P1,H,M), X(P1,H,M))
                            =L= SUP(P1) ;
*
 STAFFSHOPA(CONUS) ..  X("OBGYN",CONUS,"CLINICAL")
                     + X("OBGYN",CONUS,"TEACHING") $ (TEACH(CONUS) = 1)
                     + Y("CONTRACT",CONUS,"CLINICAL")
                     + Y("CONTRACT",CONUS,"TEACHING") $ (TEACH(CONUS) = 1)
                     + Y("PARTNER",CONUS,"CLINICAL")
                     + Y("PARTNER",CONUS,"TEACHING") $ (TEACH(CONUS) = 1)
                     =L= 50 * MTFOPEN(CONUS) ;
```

```
*
 STAFFSHOPB(CONUS) ..   3 * MTFOPEN(CONUS) =L=
                      X("OBGYN",CONUS,"CLINICAL")
                    + X("OBGYN",CONUS,"TEACHING") $ (TEACH(CONUS) = 1)
                    + Y("CONTRACT",CONUS,"CLINICAL")
                    + Y("CONTRACT",CONUS,"TEACHING") $ (TEACH(CONUS) = 1)
                    + Y("PARTNER",CONUS,"CLINICAL")
                    + Y("PARTNER",CONUS,"TEACHING") $ (TEACH(CONUS) = 1) ;
*
 EXTENDER(CONUS) ..       X("FAMPRAC",CONUS,"CLINICAL")
                          + X("MIDWIFE",CONUS,"CLINICAL")
                          =L= 25 * MTFOPEN(CONUS) ;
*
 MODEL THESIS/ALL/ ;
*
*-------------------------INVOKE OPTIMIZER-----------------------------
*
 SOLVE THESIS USING MIP MINIMIZING Z3 ;
*
*-------------------------REPORT OPTIMAL SOLUTION-----------------------
*
*DISPLAY X.L, Y.L, MTFOPEN.L, ELASTCHAMP.L, CLINUNFILL.L, TCHUNFILL.L,
*Z1.L, Z2.L, Z3.L ;
*
 PARAMETER REPORT1(*,*) CONUS MTF MILITARY ALLOCATION SUMMARY ;
 REPORT1(CONUS,"OB(C)")=X.L("OBGYN",CONUS,"CLINICAL") ;
 REPORT1(CONUS,"OB(T)")=X.L("OBGYN",CONUS,"TEACHING") ;
 REPORT1(CONUS,"FP")=X.L("FAMPRAC",CONUS,"CLINICAL") ;
 REPORT1(CONUS,"MIDWIFE")=X.L("MIDWIFE",CONUS,"CLINICAL") ;
 REPORT1("TOTAL","OB(C)")=SUM(CONUS,X.L("OBGYN",CONUS,"CLINICAL")) ;
 REPORT1("TOTAL","OB(T)")=SUM(CONUS,X.L("OBGYN",CONUS,"TEACHING")) ;
 REPORT1("TOTAL","FP")=SUM(CONUS,X.L("FAMPRAC",CONUS,"CLINICAL"));
 REPORT1("TOTAL","MIDWIFE")=SUM(CONUS,X.L("MIDWIFE",CONUS,"CLINICAL")) ;
 DISPLAY REPORT1 ;
*
 PARAMETER REPORT2(*,*) CONUS MTF CIVILIAN ALLOCATION SUMMARY ;
 REPORT2(CONUS,"CHAMPUS")=Y.L("CHAMPUS",CONUS,"CLINICAL") ;
 REPORT2(CONUS,"CONTR(C)")=Y.L("CONTRACT",CONUS,"CLINICAL") ;
 REPORT2(CONUS,"CONTR(T)")=Y.L("CONTRACT",CONUS,"TEACHING") ;
 REPORT2(CONUS,"PSHIP(C)")=Y.L("PARTNER",CONUS,"CLINICAL") ;
 REPORT2(CONUS,"PSHIP(T)")=Y.L("PARTNER",CONUS,"TEACHING") ;
 REPORT2("TOTAL","CHAMPUS")=SUM(CONUS,Y.L("CHAMPUS",CONUS,"CLINICAL")) ;
 REPORT2("TOTAL","CONTR(C)")=SUM(CONUS,Y.L("CONTRACT",CONUS,"CLINICAL"));
 REPORT2("TOTAL","CONTR(T)")=SUM(CONUS,Y.L("CONTRACT",CONUS,"TEACHING"));
 REPORT2("TOTAL","PSHIP(C)")=SUM(CONUS,Y.L("PARTNER",CONUS,"CLINICAL")) ;
 REPORT2("TOTAL","PSHIP(T)")=SUM(CONUS,Y.L("PARTNER",CONUS,"TEACHING")) ;
 DISPLAY REPORT2 ;
*
 PARAMETER REPORT3(*,*) OCONUS-ISOLATED MTF ALLOCATION SUMMARY ;
 REPORT3(OCONUS,"OB(C)")=X.L("OBGYN",OCONUS,"CLINICAL") ;
 REPORT3(OCONUS,"OB(T)")=X.L("OBGYN",OCONUS,"TEACHING") ;
 REPORT3(OCONUS,"FP")=X.L("FAMPRAC",OCONUS,"CLINICAL") ;
 REPORT3(OCONUS,"MIDWIFE")=X.L("MIDWIFE",OCONUS,"CLINICAL") ;
 REPORT3("TOTAL","OB(C)")=SUM(OCONUS,X.L("OBGYN",OCONUS,"CLINICAL")) ;
 REPORT3("TOTAL","OB(T)")=SUM(OCONUS,X.L("OBGYN",OCONUS,"TEACHING")) ;
 REPORT3("TOTAL","FP")=SUM(OCONUS,X.L("FAMPRAC",OCONUS,"CLINICAL"));
 REPORT3("TOTAL","MIDWIFE")=SUM(OCONUS,X.L("MIDWIFE",OCONUS,"CLINICAL"));
 DISPLAY REPORT3 ;
*
 PARAMETER REPORT4(*,*) ELASTIC VARIABLE SUMMARY ;
 REPORT4(H,"CLINUNFILL")=CLINUNFILL.L(H) ;
 REPORT4(H,"TCHUNFILL")=TCHUNFILL.L(H) ;
 REPORT4(H,"ELASTCHAMP")=ELASTCHAMP.L(H) ;
 DISPLAY REPORT4 ;
```

```
*
 PARAMETER REPORT5(CONUS,*) MTF OBGYN SERVICE CLOSURE SUMMARY ;
 REPORT5(CONUS,"OPEN")=MTFOPEN.L(CONUS) ;
 REPORT5(CONUS,"CLOSED")=1-MTFOPEN.L(CONUS) ;
 DISPLAY REPORT5 ;
*
 PARAMETER REPORT6(*,*) BREAKDOWN SUMMARY OF OBJECTIVE FUNCTION VALUE ;
 REPORT6("TRUE COST","Z1")=Z1.L ;
 REPORT6("PENALTY","Z2")=Z2.L ;
 REPORT6("TOTAL","Z3")=Z3.L ;
 DISPLAY REPORT6 ;
```

APPENDIX F - SENSITIVITY ANALYSIS # 1

In this scenario, the number of military OB/GYN physicians is reduced to 65. The CNMs remain at 11.

---- 704 PARAMETER REPORT1 CONUS MTF MILITARY ALLOCATION SUMMARY

	MIDWIFE	OB(C)	FP
BETHESDA		3.00	
CP-LEJEUNE	3.00	11.00	
CP-PDLTON		1.00	7.00
CHARLESTON		3.00	7.00
CHERRY-PT		3.00	5.00
JAX		1.00	7.00
OAK-HARBOR		1.00	
PAX-RIVER		3.00	
PENSACOLA			7.00
TOTAL	3.00	26.00	33.00

---- 717 PARAMETER REPORT2 CONUS MTF CIVILIAN ALLOCATION SUMMARY

	CHAMPUS	PSHIP(C)	PSHIP(T)
BEAUFORT	3.84		
BETHESDA		0.52	12.00
BREMERTON	5.45		3.00
CP-LEJEUNE	1.00	0.67	
CP-PDLTON	6.93	1.39	7.00
CHARLESTON	3.11	1.89	10.00
CHERRY-PT		0.01	
CORP-CHRIS	1.74		
GT-LAKES	5.66		
GROTON	5.19		
JAX	6.30	1.39	7.00
LONG-BEACH	11.28		
MILLINGTON	3.83		
NEWPORT	2.72		
OAK-HARBOR	0.40	2.00	
OAKLAND	4.91		11.00
ORLANDO	3.67		
PENSACOLA	1.67		5.00
PHILLY	4.39		
PORTSMOUTH	34.68		14.00
SAN-DIEGO		24.40	14.00
TOTAL	106.76	32.26	83.00

---- 728 PARAMETER REPORT3 OCONUS-ISOLATED MTF ALLOCATION SUMMARY

	MIDWIFE	OB(C)	FP
ADAK		3.00	
GUAM	1.00	3.00	3.00
GITMO-BAY		3.00	
KEFLAVIK		3.00	
LEMOORE		3.00	
NAPLES		3.00	
OKINAWA	5.00	3.00	2.00

ROOSEVELT		3.00	
ROTA		3.00	
SIGONELLA		3.00	
SUBIC-BAY	1.00	3.00	
TWTYNINE	1.00	3.00	
YOKOSUKA		3.00	
TOTAL	8.00	39.00	5.00

---- 734 PARAMETER REPORT4 ELASTIC VARIABLE SUMMARY

	ELASTCHAMP
CP-LEJEUNE	3.67

---- 739 PARAMETER REPORT5 MTF OBGYN SERVICE CLOSURE SUMMARY

	OPEN	CLOSED
BEAUFORT		X
BETHESDA	X	
BREMERTON	X	
CP-LEJEUNE	X	
CP-PDLTON	X	
CHARLESTON	X	
CHERRY-PT	X	
CORP-CHRIS		X
GT-LAKES		X
GROTON		X
JAX	X	
LONG-BEACH		X
MILLINGTON		X
NEWPORT		X
OAK-HARBOR	X	
OAKLAND	X	
ORLANDO		X
PAX-RIVER	X	
PENSACOLA	X	
PHILLY		X
PORTSMOUTH	X	
SAN-DIEGO	X	

APPENDIX G - SENSITIVITY ANALYSIS # 2

In this scenario, the number of military OB/GYN physicians is increased to 113. CNMs remain at 11.

---- 704 PARAMETER REPORT1 CONUS MTF MILITARY ALLOCATION SUMMARY

	MIDWIFE	OB(C)	OB(T)	FP
BETHESDA		3.00	1.00	
BREMERTON			3.00	
CP-LEJEUNE	3.00	11.00		
CP-PDLTON		1.00		7.00
CHARLESTON		3.00		9.00
CHERRY-PT		3.00		5.00
JAX		1.00	7.00	9.00
OAK-HARBOR		3.00		
OAKLAND			11.00	
PAX-RIVER		3.00		
PENSACOLA		1.00		7.00
SAN-DIEGO		23.00		
TOTAL	3.00	52.00	22.00	37.00

---- 717 PARAMETER REPORT2 CONUS MTF CIVILIAN ALLOCATION SUMMARY

	CHAMPUS	PSHIP(C)	PSHIP(T)
BEAUFORT	3.84		
BETHESDA		0.52	11.00
BREMERTON	5.45		
CP-LEJEUNE	1.00	0.67	
CP-PDLTON	6.93	1.39	7.00
CHARLESTON	3.11	1.22	10.00
CHERRY-PT		0.01	
CORP-CHRIS	1.74		
GT-LAKES	5.66		
GROTON	5.19		
JAX	6.30	0.72	
LONG-BEACH	11.28		
MILLINGTON	3.83		
NEWPORT	2.72		
OAK-HARBOR	0.40		
OAKLAND	4.91		
ORLANDO	3.67		
PENSACOLA	0.67		5.00
PHILLY	4.39		
PORTSMOUTH	34.68		14.00
SAN-DIEGO		1.40	14.00
TOTAL	105.76	5.93	61.00

---- 728 PARAMETER REPORT3 OCONUS-ISOLATED MTF ALLOCATION SUMMARY

	MIDWIFE	OB(C)	FP
ADAK		3.00	
GUAM	1.00	3.00	3.00
GITMO-BAY		3.00	
KEFLAVIK		3.00	

LEMOORE		3.00	
NAPLES		3.00	
OKINAWA	5.00	3.00	2.00
ROOSEVELT		3.00	
ROTA		3.00	
SIGONELLA		3.00	
SUBIC-BAY	1.00	3.00	
TWTYNINE	1.00	3.00	
YOKOSUKA		3.00	
TOTAL	8.00	39.00	5.00

---- 734 PARAMETER REPORT4 ELASTIC VARIABLE SUMMARY

	ELASTCHAMP
CP-LEJEUNE	3.67

---- 739 PARAMETER REPORT5 MTF OBGYN SERVICE CLOSURE SUMMARY

	OPEN	CLOSED
BEAUFORT		X
BETHESDA	X	
BREMERTON	X	
CP-LEJEUNE	X	
CP-PDLTON	X	
CHARLESTON	X	
CHERRY-PT	X	
CORP-CHRIS		X
GT-LAKES		X
GROTON		X
JAX	X	
LONG-BEACH		X
MILLINGTON		X
NEWPORT		X
OAK-HARBOR	X	
OAKLAND	X	
ORLANDO		X
PAX-RIVER	X	
PENSACOLA	X	
PHILLY		X
PORTSMOUTH	X	
SAN-DIEGO	X	

APPENDIX H - SENSITIVITY ANALYSIS # 3

In this scenario, the number of military OB/GYN physicians is reduced to 65. The CNMs are increased to 20.

---- 705 PARAMETER REPORT1 CONUS MTF MILITARY ALLOCATION SUMMARY

	MIDWIFE	OB(C)	FP
BETHESDA		3.00	
CP-LEJEUNE	13.00	3.00	
CP-PDLTON		2.00	7.00
CHARLESTON		3.00	9.00
CHERRY-PT		3.00	5.00
JAX		1.00	9.00
OAK-HARBOR		3.00	
PAX-RIVER		3.00	
PENSACOLA			7.00
SAN-DIEGO		5.00	
TOTAL	13.00	26.00	37.00

---- 718 PARAMETER REPORT2 CONUS MTF CIVILIAN ALLOCATION SUMMARY

	CHAMPUS	CONTR(C)	PSHIP(C)	PSHIP(T)
BEAUFORT	3.84			
BETHESDA			0.52	12.00
BREMERTON	5.45			3.00
CP-LEJEUNE	1.00	1.00	1.00	
CP-PDLTON	6.93		0.39	7.00
CHARLESTON	3.11		1.22	10.00
CHERRY-PT			0.01	
CORP-CHRIS	1.74			
GT-LAKES	5.66			
GROTON	5.19			
JAX	6.30		0.72	7.00
LONG-BEACH	11.28			
MILLINGTON	3.83			
NEWPORT	2.72			
OAK-HARBOR	0.40			
OAKLAND	4.91			11.00
ORLANDO	3.67			
PENSACOLA	1.67			5.00
PHILLY	4.39			
PORTSMOUTH	34.68			14.00
SAN-DIEGO			19.40	14.00
TOTAL	106.76	1.00	23.26	83.00

---- 729 PARAMETER REPORT3 OCONUS-ISOLATED MTF ALLOCATION SUMMARY

	MIDWIFE	OB(C)	FP
ADAK		3.00	
GUAM		3.00	6.00
GITMO-BAY		3.00	
KEFLAVIK		3.00	
LEMOORE		3.00	
NAPLES		3.00	

OKINAWA	5.00	3.00	1.00
ROOSEVELT		3.00	
ROTA		3.00	
SIGONELLA		3.00	
SUBIC-BAY	1.00	3.00	
TWTYNINE	1.00	3.00	
YOKOSUKA		3.00	
TOTAL	7.00	39.00	7.00

---- 735 PARAMETER REPORT4 ELASTIC VARIABLE SUMMARY

	ELASTCHAMP
CP-LEJEUNE	3.67

---- 740 PARAMETER REPORT5 MTF OBGYN SERVICE CLOSURE SUMMARY

	OPEN	CLOSED
BEAUFORT		X
BETHESDA	X	
BREMERTON	X	
CP-LEJEUNE	X	
CP-PDLTON	X	
CHARLESTON	X	
CHERRY-PT	X	
CORP-CHRIS		X
GT-LAKES		X
GROTON		X
JAX	X	
LONG-BEACH		X
MILLINGTON		X
NEWPORT		X
OAK-HARBOR	X	
OAKLAND	X	
ORLANDO		X
PAX-RIVER	X	
PENSACOLA	X	
PHILLY		X
PORTSMOUTH	X	
SAN-DIEGO	X	

APPENDIX I - SENSITIVITY ANALYSIS # 4

In this scenario, the number of military OB/GYN physicians remain at 86. The CNMs are increased to 20.

---- 705 PARAMETER REPORT1 CONUS MTF MILITARY ALLOCATION SUMMARY

	MIDWIFE	OB(C)	FP
BETHESDA		3.00	
CP-LEJEUNE	11.00	5.00	
CP-PDLTON		1.00	7.00
CHARLESTON		4.00	7.00
CHERRY-PT	1.00	3.00	3.00
JAX	1.00	1.00	9.00
OAK-HARBOR		3.00	
PAX-RIVER		3.00	
PENSACOLA		1.00	7.00
SAN-DIEGO		23.00	
TOTAL	13.00	47.00	33.00

---- 718 PARAMETER REPORT2 CONUS MTF CIVILIAN ALLOCATION SUMMARY

	CHAMPUS	CONTR(C)	PSHIP(C)	PSHIP(T)
BEAUFORT	3.84			
BETHESDA			0.52	12.00
BREMERTON	5.45			3.00
CP-LEJEUNE	1.00	0.33	1.00	
CP-PDLTON	6.93		1.39	7.00
CHARLESTON	3.11		0.89	10.00
CHERRY-PT			0.01	
CORP-CHRIS	1.74			
GT-LAKES	5.66			
GROTON	5.19			
JAX	6.30		0.06	7.00
LONG-BEACH	11.28			
MILLINGTON	3.83			
NEWPORT	2.72			
OAK-HARBOR	0.40			
OAKLAND	4.91			11.00
ORLANDO	3.67			
PENSACOLA	0.67			5.00
PHILLY	4.39			
PORTSMOUTH	34.68			14.00
SAN-DIEGO			1.40	14.00
TOTAL	105.76	0.33	5.26	83.00

---- 729 PARAMETER REPORT3 OCONUS-ISOLATED MTF ALLOCATION SUMMARY

	MIDWIFE	OB(C)	FP
ADAK		3.00	
GUAM	2.00	3.00	1.00
GITMO-BAY		3.00	
KEFLAVIK		3.00	
LEMOORE		3.00	
NAPLES		3.00	

OKINAWA	3.00	3.00	5.00
ROOSEVELT		3.00	
ROTA		3.00	
SIGONELLA		3.00	
SUBIC-BAY	1.00	3.00	
TWTYNINE	1.00	3.00	
YOKOSUKA		3.00	
TOTAL	7.00	39.00	6.00

---- 735 PARAMETER REPORT4 ELASTIC VARIABLE SUMMARY

	ELASTCHAMP
CP-LEJEUNE	3.67

---- 740 PARAMETER REPORT5 MTF OBGYN SERVICE CLOSURE SUMMARY

	OPEN	CLOSED
BEAUFORT		X
BETHESDA	X	
BREMERTON	X	
CP-LEJEUNE	X	
CP-PDLTON	X	
CHARLESTON	X	
CHERRY-PT	X	
CORP-CHRIS		X
GT-LAKES		X
GROTON		X
JAX	X	
LONG-BEACH		X
MILLINGTON		X
NEWPORT		X
OAK-HARBOR	X	
OAKLAND	X	
ORLANDO		X
PAX-RIVER	X	
PENSACOLA	X	
PHILLY		X
PORTSMOUTH	X	
SAN-DIEGO	X	

APPENDIX J - SENSITIVITY ANALYSIS # 5

In this scenario, the number of military OB/GYN physicians is increased to 113. The CNMs are increased to 20.

---- 705 PARAMETER REPORT1 CONUS MTF MILITARY ALLOCATION SUMMARY

	MIDWIFE	OB(C)	OB(T)	FP
BETHESDA		3.00	13.00	
BREMERTON			3.00	
CP-LEJEUNE	13.00	3.00		
CP-PDLTON		2.00		7.00
CHARLESTON		4.00		7.00
CHERRY-PT		3.00		5.00
JAX		1.00	7.00	9.00
OAK-HARBOR		3.00		
OAKLAND			11.00	
PAX-RIVER		3.00		
PENSACOLA		1.00	2.00	7.00
SAN-DIEGO		15.00		
TOTAL	13.00	38.00	36.00	35.00

---- 718 PARAMETER REPORT2 CONUS MTF CIVILIAN ALLOCATION SUMMARY

	CHAMPUS	CONTR(C)	PSHIP(C)	PSHIP(T)
BEAUFORT	3.84			
BETHESDA			0.24	
BREMERTON	5.45			
CP-LEJEUNE	1.00	1.00	1.00	
CP-PDLTON	6.93		0.39	7.00
CHARLESTON	3.11		0.89	10.00
CHERRY-PT			0.01	
CORP-CHRIS	1.74			
GT-LAKES	5.66			
GROTON	5.19			
JAX	6.30		0.72	
LONG-BEACH	11.28			
MILLINGTON	3.83			
NEWPORT	2.72			
OAK-HARBOR	0.40			
OAKLAND	4.91			
ORLANDO	3.67			
PENSACOLA	0.67			3.00
PHILLY	4.39			
PORTSMOUTH	34.68			14.00
SAN-DIEGO			9.40	14.00
TOTAL	105.76	1.00	12.65	48.00

---- 729 PARAMETER REPORT3 OCONUS-ISOLATED MTF ALLOCATION SUMMARY

	MIDWIFE	OB(C)	FP
ADAK		3.00	
GUAM		3.00	8.00
GITMO-BAY		3.00	
KEFLAVIK		3.00	

LEMOORE		3.00	
NAPLES		3.00	
OKINAWA	5.00	3.00	1.00
ROOSEVELT		3.00	
ROTA		3.00	
SIGONELLA		3.00	
SUBIC-BAY	1.00	3.00	
TWTYNINE	1.00	3.00	
YOKOSUKA		3.00	
TOTAL	7.00	39.00	9.00

---- 735 PARAMETER REPORT4 ELASTIC VARIABLE SUMMARY

	ELASTCHAMP
CP-LEJEUNE	3.67

---- 740 PARAMETER REPORT5 MTF OBGYN SERVICE CLOSURE SUMMARY

	OPEN	CLOSED
BEAUFORT		X
BETHESDA	X	
BREMERTON	X	
CP-LEJEUNE	X	
CP-PDLTON	X	
CHARLESTON	X	
CHERRY-PT	X	
CORP-CHRIS		X
GT-LAKES		X
GROTON		X
JAX	X	
LONG-BEACH		X
MILLINGTON		X
NEWPORT		X
OAK-HARBOR	X	
OAKLAND	X	
ORLANDO		X
PAX-RIVER	X	
PENSACOLA	X	
PHILLY		X
PORTSMOUTH	X	
SAN-DIEGO	X	

APPENDIX K - SENSITIVITY ANALYSIS # 6

In this scenario, delivery rooms are opened at those facilities that currently do not have delivery rooms in service.

---- 705 PARAMETER REPORT1 CONUS MTF MILITARY ALLOCATION SUMMARY

	MIDWIFE	OB(C)	FP
BETHESDA		3.00	
CP-LEJEUNE	7.00	7.00	
CP-PDLTON		1.00	7.00
CHARLESTON		3.00	7.00
CHERRY-PT		3.00	3.00
JAX		1.00	7.00
OAK-HARBOR		3.00	
PAX-RIVER		3.00	
PENSACOLA			7.00
SAN-DIEGO		23.00	
TOTAL	7.00	47.00	31.00

---- 718 PARAMETER REPORT2 CONUS MTF CIVILIAN ALLOCATION SUMMARY

	CHAMPUS	CONTR(C)	PSHIP(C)	PSHIP(T)
BEAUFORT	3.84			
BETHESDA			0.52	12.00
BREMERTON	5.45			3.00
CP-LEJEUNE	1.00	1.00	1.00	
CP-PDLTON	6.93		1.39	7.00
CHARLESTON	3.11		1.89	10.00
CHERRY-PT			0.68	
CORP-CHRIS	1.74			
GT-LAKES	5.66			
GROTON	5.19			
JAX	6.30		1.39	7.00
LONG-BEACH	11.28			
MILLINGTON	3.83			
NEWPORT	2.72			
OAK-HARBOR	0.40			
OAKLAND	4.91			11.00
ORLANDO	3.67			
PENSACOLA	1.67			5.00
PHILLY	4.39			
PORTSMOUTH	34.68			14.00
SAN-DIEGO			1.40	14.00
TOTAL	106.76	1.00	8.26	83.00

---- 729 PARAMETER REPORT3 OCONUS-ISOLATED MTF ALLOCATION SUMMARY

	MIDWIFE	OB(C)	FP
ADAK		3.00	
GUAM		3.00	8.00
GITMO-BAY		3.00	
KEFLAVIK		3.00	

LEMOORE		3.00	
NAPLES		3.00	
OKINAWA	4.00	3.00	3.00
ROOSEVELT		3.00	
ROTA		3.00	
SIGONELLA		3.00	
SUBIC-BAY		3.00	1.00
TWTYNINE		3.00	2.00
YOKOSUKA		3.00	
TOTAL	4.00	39.00	14.00

---- 735 PARAMETER REPORT4 ELASTIC VARIABLE SUMMARY

	CLINUNFILL	ELASTCHAMP
CP-LEJEUNE		3.67
SUBIC-BAY	13.00	

---- 740 PARAMETER REPORT5 MTF OBGYN SERVICE CLOSURE SUMMARY

	OPEN	CLOSED
BEAUFORT		X
BETHESDA	X	
BREMERTON	X	
CP-LEJEUNE	X	
CP-PDLTON	X	
CHARLESTON	X	
CHERRY-PT	X	
CORP-CHRIS		X
GT-LAKES		X
GROTON		X
JAX	X	
LONG-BEACH		X
MILLINGTON		X
NEWPORT		X
OAK-HARBOR	X	
OAKLAND	X	
ORLANDO		X
PAX-RIVER	X	
PENSACOLA	X	
PHILLY		X
PORTSMOUTH	X	
SAN-DIEGO	X	

APPENDIX L - SENSITIVITY ANALYSIS # 7

In this scenario, the requirement to maintain the Graduate Medical Education programs at the teaching hospitals is relaxed.

---- 705 PARAMETER REPORT1 CONUS MTF MILITARY ALLOCATION SUMMARY

	MIDWIFE	OB	FP
BETHESDA	1.00	5.00	
CP-LEJEUNE	5.00	10.00	
CHERRY-PT		3.00	5.00
OAK-HARBOR		3.00	
PAX-RIVER		3.00	
PENSACOLA		3.00	7.00
SAN-DIEGO		20.00	
TOTAL	6.00	47.00	12.00

---- 718 PARAMETER REPORT2 CONUS MTF CIVILIAN ALLOCATION SUMMARY

	CHAMPUS	PSHIP
BEAUFORT	3.84	
BETHESDA		1.18
BREMERTON	6.28	
CP-LEJEUNE	1.00	0.33
CP-PDLTON	13.60	
CHARLESTON	13.11	
CHERRY-PT		0.01
CORP-CHRIS	1.74	
GT-LAKES	5.66	
GROTON	5.19	
JAX	12.97	
LONG-BEACH	11.28	
MILLINGTON	3.83	
NEWPORT	2.72	
OAK-HARBOR	0.40	
OAKLAND	7.96	
ORLANDO	3.67	
PENSACOLA	0.06	
PHILLY	4.39	
PORTSMOUTH	38.57	
SAN-DIEGO		8.29
TOTAL	136.26	9.82

---- 729 PARAMETER REPORT3 OCONUS-ISOLATED MTF ALLOCATION SUMMARY

	MIDWIFE	OB	FP
ADAK		3.00	
GUAM	1.00	3.00	3.00
GITMO-BAY		3.00	
KEFLAVIK		3.00	
LEMOORE		3.00	
NAPLES		3.00	
OKINAWA	2.00	3.00	7.00

ROOSEVELT		3.00	
ROTA		3.00	
SIGONELLA		3.00	
SUBIC-BAY	1.00	3.00	
TWTYNINE	1.00	3.00	
YOKOSUKA		3.00	
TOTAL	5.00	39.00	10.00

---- 735 PARAMETER REPORT4 ELASTIC VARIABLE SUMMARY

	ELASTCHAMP
CP-LEJEUNE	3.67

---- 740 PARAMETER REPORT5 MTF OBGYN SERVICE CLOSURE SUMMARY

	OPEN	CLOSED
BEAUFORT		X
BETHESDA	X	
BREMERTON		X
CP-LEJEUNE	X	
CP-PDLTON		X
CHARLESTON		X
CHERRY-PT	X	
CORP-CHRIS		X
GT-LAKES		X
GROTON		X
JAX		X
LONG-BEACH		X
MILLINGTON		X
NEWPORT		X
OAK-HARBOR	X	
OAKLAND		X
ORLANDO		X
PAX-RIVER	X	
PENSACOLA	X	
PHILLY		X
PORTSMOUTH		X
SAN-DIEGO	X	

APPENDIX M - SENSITIVITY ANALYSIS # 8

In this scenario, the supplies of CHAMPUS, contract, and partnership OB/GYN physicians available to Camp Lejeune are increased from one to ten.

---- 704 PARAMETER REPORT1 CONUS MTF MILITARY ALLOCATION SUMMARY

	MIDWIFE	OB(C)	OB(T)	FP
BETHESDA	1.00	2.00	1.00	
BREMERTON			3.00	
CP-LEJEUNE	2.00	3.00		
CP-PDLTON		1.00		7.00
CHARLESTON		3.00		7.00
CHERRY-PT		3.00		5.00
JAX		1.00	1.00	7.00
OAK-HARBOR		3.00		
OAKLAND			7.00	
PAX-RIVER		3.00		
PENSACOLA		1.00		7.00
SAN-DIEGO		15.00		
TOTAL	3.00	35.00	12.00	33.00

---- 717 PARAMETER REPORT2 CONUS MTF CIVILIAN ALLOCATION SUMMARY

	CHAMPUS	PSHIP(C)	PSHIP(T)
BEAUFORT	3.84		
BETHESDA		0.85	11.00
BREMERTON	5.45		
CP-LEJEUNE	10.00	0.33	
CP-PDLTON	6.93	1.39	7.00
CHARLESTON	3.11	1.89	10.00
CHERRY-PT		0.01	
CORP-CHRIS	1.74		
GT-LAKES	5.66		
GROTON	5.19		
JAX	6.30	1.39	6.00
LONG-BEACH	11.28		
MILLINGTON	3.83		
NEWPORT	2.72		
OAK-HARBOR	0.40		
OAKLAND	4.91		4.00
ORLANDO	3.67		
PENSACOLA	0.67		5.00
PHILLY	4.39		
PORTSMOUTH	34.68		14.00
SAN-DIEGO		9.40	14.00
TOTAL	114.76	15.26	71.00

---- 728 PARAMETER REPORT3 OCONUS-ISOLATED MTF ALLOCATION SUMMARY

	MIDWIFE	OB(C)	FP
ADAK		3.00	
GUAM	1.00	3.00	3.00

GITMO-BAY		3.00	
KEFLAVIK		3.00	
LEMOORE		3.00	
NAPLES		3.00	
OKINAWA	5.00	3.00	2.00
ROOSEVELT		3.00	
ROTA		3.00	
SIGONELLA		3.00	
SUBIC-BAY	1.00	3.00	
TWTYNINE	1.00	3.00	
YOKOSUKA		3.00	
TOTAL	8.00	39.00	5.00

---- 734 PARAMETER REPORT4 ELASTIC VARIABLE SUMMARY

(ALL 0.00)

---- 739 PARAMETER REPORT5 MTF OBGYN SERVICE CLOSURE SUMMARY

	OPEN	CLOSED
BEAUFORT		X
BETHESDA	X	
BREMERTON	X	
CP-LEJEUNE	X	
CP-PDLTON	X	
CHARLESTON	X	
CHERRY-PT	X	
CORP-CHRIS		X
GT-LAKES		X
GROTON		X
JAX	X	
LONG-BEACH		X
MILLINGTON		X
NEWPORT		X
OAK-HARBOR	X	
OAKLAND	X	
ORLANDO		X
PAX-RIVER	X	
PENSACOLA	X	
PHILLY		X
PORTSMOUTH	X	
SAN-DIEGO	X	

APPENDIX N - SENSITIVITY ANALYSIS # 9

In this scenario, the relative ordering of costs assumed to be CNM < FP < partnership < contract in the initial case is changed to partnership < contract < CNM < FP.

---- 706 PARAMETER REPORT1 CONUS MTF MILITARY ALLOCATION SUMMARY

	MIDWIFE	OB(C)
CP-LEJEUNE	1.00	11.00
PAX-RIVER		3.00
TOTAL	1.00	14.00

---- 719 PARAMETER REPORT2 CONUS MTF CIVILIAN ALLOCATION SUMMARY

	CHAMPUS	CONTR(C)	PSHIP(C)	PSHIP(T)
BEAUFORT	3.84			
BETHESDA			3.52	12.00
BREMERTON			5.45	3.00
CP-LEJEUNE	1.00	1.00	1.00	
CP-PDLTON	6.93		4.72	7.00
CHARLESTON	3.11		7.22	10.00
CHERRY-PT			4.68	
CORP-CHRIS	1.74			
GT-LAKES	5.66			
GROTON	5.19			
JAX	6.30		4.72	7.00
LONG-BEACH	11.28			
MILLINGTON	3.83			
NEWPORT	2.72			
OAK-HARBOR	0.40		3.00	
OAKLAND	4.91			11.00
ORLANDO	3.67			
PENSACOLA			4.01	5.00
PHILLY	4.39			
PORTSMOUTH	25.24		9.44	14.00
SAN-DIEGO			24.40	14.00
TOTAL	90.19	1.00	72.16	83.00

---- 730 PARAMETER REPORT3 OCONUS-ISOLATED MTF ALLOCATION SUMMARY

	MIDWIFE	OB(C)	FP
ADAK		3.00	
GUAM	1.00	3.00	3.00
GITMO-BAY		3.00	
KEFLAVIK		3.00	
LEMOORE		3.00	
NAPLES		3.00	
OKINAWA	3.00	3.00	6.00
ROOSEVELT		3.00	
ROTA		3.00	
SIGONELLA		3.00	
SUBIC-BAY		3.00	2.00
TWTYNINE		3.00	1.00

YOKOSUKA		3.00	
TOTAL	4.00	39.00	12.00

---- 736 PARAMETER REPORT4 ELASTIC VARIABLE SUMMARY

	ELASTCHAMP
CP-LEJEUNE	3.67

---- 741 PARAMETER REPORT5 MTF OBGYN SERVICE CLOSURE SUMMARY

	OPEN	CLOSED
BEAUFORT		X
BETHESDA	X	
BREMERTON	X	
CP-LEJEUNE	X	
CP-PDLTON	X	
CHARLESTON	X	
CHERRY-PT	X	
CORP-CHRIS		X
GT-LAKES		X
GROTON		X
JAX	X	
LONG-BEACH		X
MILLINGTON		X
NEWPORT		X
OAK-HARBOR	X	
OAKLAND	X	
ORLANDO		X
PAX-RIVER	X	
PENSACOLA	X	
PHILLY		X
PORTSMOUTH	X	
SAN-DIEGO	X	

LIST OF REFERENCES

1. *Bureau of Medicine and Surgery* (MED-5121) Memorandum, Subject: Obstetrics and Gynecology Training Pipeline, 2 October 1991.

2. *Bureau of Medicine and Surgery* (MED-3C11JF) Memorandum, Subject: Obstetrics and Gynecology Staffing for FY-93, 26 August 1991.

3. *Naval Medical Data Services Center* Memorandum 6000 Ser 41/1174, Subject: FY-90 Health Care Planning Matrix (HCPM), 11 July 1991.

4. *Bureau of Medicine and Surgery*, Subject: Command Briefing, November 1991.

5. Telephone conversation between LT T. G. Mihara, MSC, USN, MED-13, *Bureau of Medicine and Surgery* and the author, April 1992.

6. *Assistant Secretary of Defense (Health Affairs)*, Subject: FY-89 Diagnosis Related Groups Based Resource Allocation Guidance, 5 August 1988.

7. Physicians' Current Procedural Terminology (CPT), 4th ed., p. iii, American Medical Association, 1991.

8. *Bureau of Medicine and Surgery* Report, Subject: FY-90 Medical Expense and Performance Reporting System (MEPRS) Data, May 1991.

9. *OCHAMPUS Statistics Branch* Report, Subject: CHAMPUS Health Care Summary by Primary Diagnosis, January 1991.

10. *Bureau of Medicine and Surgery* (MED-3223) Memorandum, Subject: Obstetrics/Gynecology Specialty Distribution Plan, 8 January 1990.

11. *Bureau of Medicine and Surgery* (MED-3223) Memorandum, Subject: Navy Certified Nurse Midwives - Proposal for Phased Community Growth, 24 April 1991.

12. *Bureau of Medicine and Surgery* (MED-5414) Instruction 6550.2, Subject: Utilization Guidelines for Nurse-Midwives, 6 February 1985.

13. *Bureau of Medicine and Surgery* (MED-312) Instruction 6320.29, Subject: Military-Civilian Health Services Partnership Program, 3 March 1988.

14. *Bureau of Medicine and Surgery* (MED-3C22) Instruction 4283.1, Subject: Health Care Contracting, 6 November 1991.

15. *Bureau of Medicine and Surgery* Memorandum 1040 Ser OOMCB/0402, Subject: Status of Obstetrics/Gynecology Retention Issues, 2 April 1991.

16. Schrage, L., LINDO, 3rd ed., The Scientific Press, 1988.

17. Brooke, A., Kendrick, D., and Meeraus, A., GAMS: A User's Guide, The Scientific Press, 1988.

18. Byer, J. R., Professional Linear Programming XA, Sunset Software Technology, 1987.

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